Research Management Processes under Rapid Change

The Danish Institute for Studies
in Research and Research Policy
2003/9

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Report from The Danish Institute for Studies in Research and Research Policy 2003/9

Published by:
The Danish Institute for Studies in Research and Research Policy
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The report can be downloaded from the homepage of
The Danish Institute for Studies in Research and Research Policy:
http://www.afsk.au.dk

This report is available on enquery to the publisher.
Price: DKR 100,00.

Print: GP-Tryk A/S, Grenaa
Number printed: 750
ISBN: 87-90698-84-3
ISSN: 1398-1471

Preface

The REMAP project (R&D Management Processes under Rapid Change) – is a research partnership between The Department of Management, Politics and Philosophy (Copenhagen Business School), The Danish Institute for Studies in Research and Research Policy, RISØ National Laboratory and six research based Danish companies. REMAP is initiated under the governmental programme “Co-operation between Governmental Research Institutes, Universities and Private Sector” and funded by the Danish Research Councils. The project aimed to develop an integrated model for understanding, managing, prioritising and evaluating complex research and development processes in public and private R&D. In particular the REMAP project focuses on the identification of various complementary selection criteria and tools necessary for an early assessment of knowledge creating processes. The project has an interdisciplinary approach, which bridges the gap between theory and application, practice and learning, knowledge accumulation, education and the main institutional actors in the triple helix i.e. the relationship between higher education institutions, industry and governmental agencies.

This anthology gives a series of presentations from REMAP related projects, not all projects were from the beginning core projects. Several of the projects within REMAP have been published in other context or are under way to journals etc.

This volume therefore only gives a selected series of articles of which several have emphasised science policy as the frame for research management, but the volume also highlights models and methods of significant relevance for studies of research management.

The articles published here are all the results of a REMAP workshop held in November 2003; they all discuss research management in one or several contexts and the emphasis is on changes.

Karen Siune
Member of the steering board for REMAP

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Chapter 1: Science and Society

1.1. Introduction

Karen Siune
The Danish Institute for Studies in Research and Research Policy

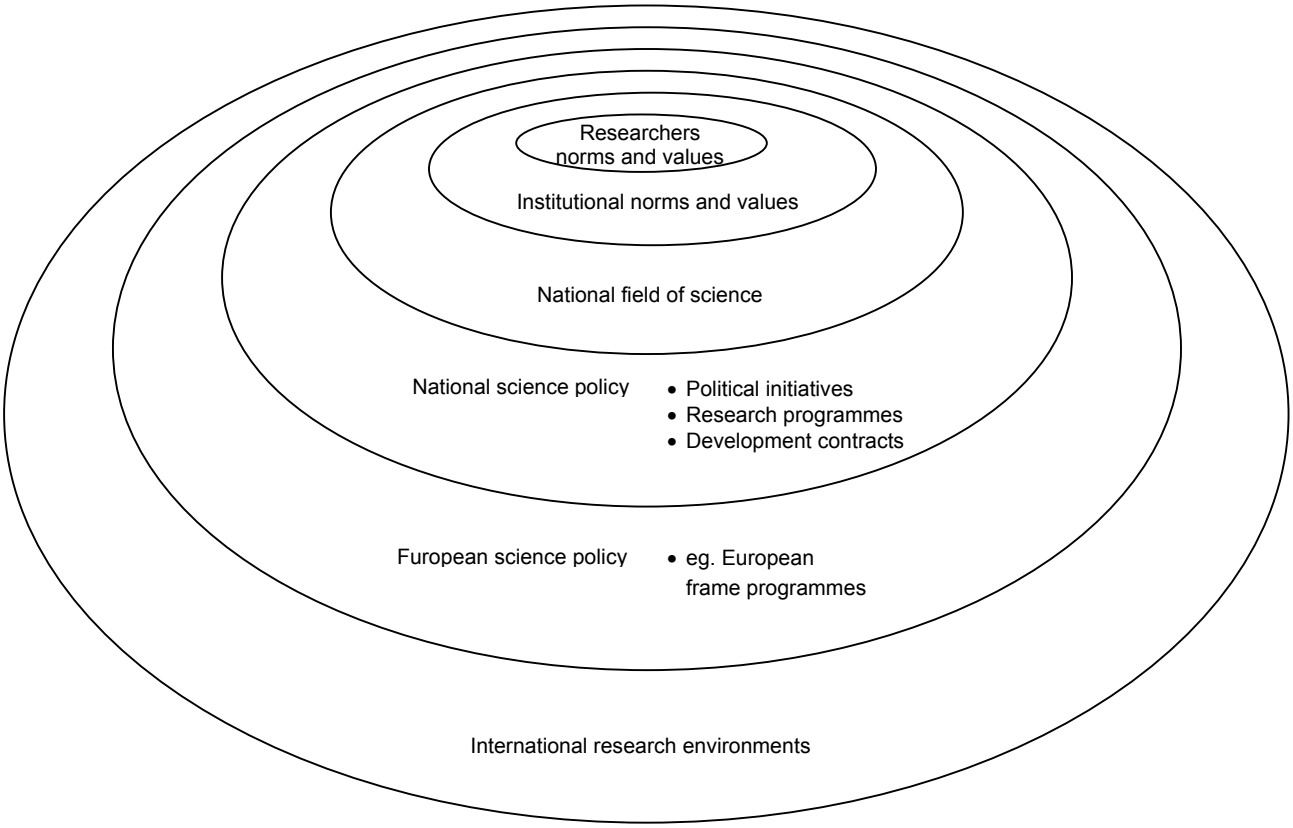
Research management is the central issue in this anthology. The issue has been discussed intensively throughout Europe, as R&D management processes have been under rapid change in the last decade. Research management takes place at many levels from the policy level to the actual research institutes and laboratories. Within the REMAP project several levels of research management have been studied that are presented in the contributions to the anthology.

The REMAP project (R&D Management Processes under Rapid Change) – is a research partnership between The Department of Management, Politics and Philosophy (Copenhagen Business School), The Danish Institute for Studies in Research and Research Policy, RISØ National Laboratory and six research based Danish companies. REMAP is initiated under the governmental programme “Co-operation between Governmental Research Institutes, Universities and Private Sector” and funded by the Danish Research Councils. The project aimed to develop an integrated model for understanding, managing, prioritising and evaluating complex research and development processes in public and private R&D. In particular the REMAP project focuses on the identification of various complementary selection criteria and tools necessary for an early assessment of knowledge creating processes. The REMAP project had from the beginning an interdisciplinary approach, which bridges the gap between theory and application, practice and learning, knowledge accumulation, education and the main institutional actors in the triple helix i.e. the relationship between higher education institutions, industry and governmental agencies.

The long-term perspectives of the REMAP project offer research policymakers, public researchers and private companies an opportunity to understand the complexities underlying R&D management and how to apply appropriate methods and evaluation procedures.

In the center of all research management is the researcher and his/her activities (fig.1). The individual researcher has scientific and cultural norms and values guiding his or hers research activity of which much is formed through educational training. Almost all researchers work within a kind of institutional setting and at the institutional level we can find norms, values and cultures characterizing the specific institution. In a comparative perspective at a European level we find variations in norms, values and cultures, but at the same time we find policy and management initiatives that are common to all types of research across Europe and across sciences.

Figure 1. Norms and values in science policy context

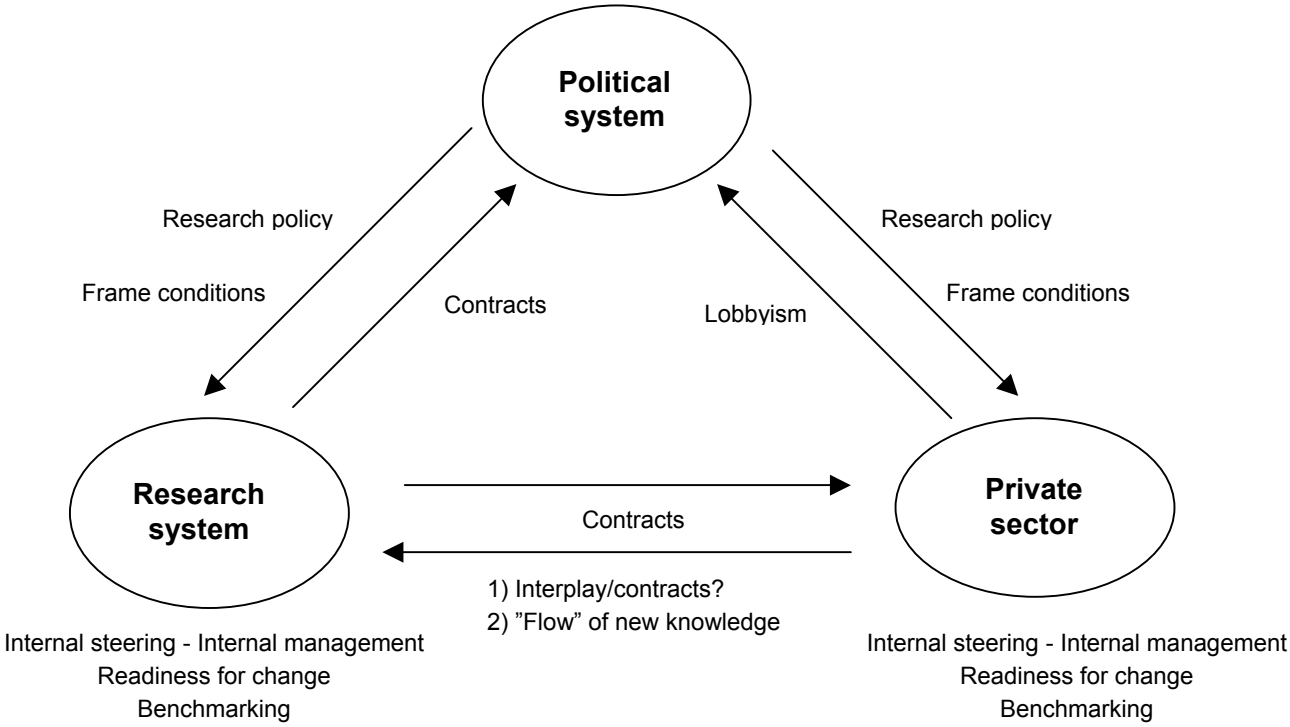


Basically the REMAP project focus was on management under rapid change. In some of the studies within the REMAP frame the emphasis was on project management as such, while other studies from the very beginning had the attention directed towards the policy level: what kind of policy initiatives were forming frames for research management. In this report there are several articles that have as starting point science policy as the frame condition for their study (Siune, Siune and Aagaard, Borup, Brink Andersen, 2004).

One study within the core of REMAP focused on the interplay between public research and private enterprises (Kalpazidou Schmidt). This project relates directly to the intentions of the policy initiative funding the REMAP project, since one of the main intentions with the initiative taken by the funding organisation was to make a strategic research programme to increase the interaction between universities, governmental research institutes and private enterprises.

In figure 2 a model of the interfaces between different types of actors of relevance to science is presented. In theory as well as in practice the political system, the research system and the private sector should be studied in their interaction when we want to analyse the interplay between science and society as a kind of Triple Helix (Etzkowitz and Leydesdorff, 2000). When studying science and society interplay in its wider context a fourth central actor is the public as such; the role of citizens shall ideally be included (Nowotny, 2000, Mejlgaard and Siune, 2002)

Figure 2. Knowledge management - Interplay between and within science based institutions



In the articles presented in this report, based on a REMAP seminar organized in November 2003, the elements in the knowledge management interplay between and within science based institutions are studied in different contexts, most of them with focus on one of the sides in the triangle (see figure 2).

The interaction between the public research system and the private sector is a central issue in the science and society interplay. This theme, which has been a core project within the REMAP framework, is presented by Evanthia Kalpazidou Schmidt who also focuses on the private sector attitudes on public research and on the wishes from the private sector to public science policy.

In many ways there is an uncertainty in science policymaking, partly due to many different types of actors interested in setting the agenda for science and public research, and due to those problems we observed when we concluded that science is under pressure (ed. Siune 2001). In the EU-STRATA project "Managing with Uncertainty in Science Policy", which has been coordinated by Karen Siune under the acronym MUSCIPOLI, reactions to this uncertainty is studied based on European experiences. In the article presented here Siune draws on the European experiences and lists a series of potential responses at the institutional level stated as reactions to policy initiatives.

Based on European case studies of inter- and pluri-disciplinary research activities the management problems related specifically to cross disciplinarity research are presented by Siune and Aagaard.

At a national level the political system and its initiatives concerning public research has been studied by Peter Brink Andersen looking at contracts between universities and ministries as a result of science policy.

Also with focus at the national level Mads Borup presents a case study of the Danish research councils strategic programme activity.

A central issue for science policy and management is how to establish dynamic research environments. In the article by Ebbe Krogh Graversen, Evanthia Kalpazidou Schmidt and Kamma Langberg a model for the development of dynamic and innovative research environments is presented. The model is discussed based on a number of Danish case studies. The results may be a valid tool for policymakers and research managers.

Mette Mønsted discusses new leadership roles toward knowledge workers and she focuses on the management implications of asymmetric knowledge, and how to deal with knowledge sharing for constructing a platform for decision-making and management. Her experience is based on small IT-firms.

Research management is complicated to study, but nonetheless Kamma Langberg has established models for how to study the research performance function. The Research Performance Function (RPF) combines input to the research process with all the decision- levels that have to be taken into account for research managers and transforms it to research outcomes.

Scenarios might be a tool in research management. Cynthia Selin presents in her article how scenarios can be of relevance for research management. She emphasizes that a very important job of scenario planning is "the shifting of mental models, or the orchestrating of perceptual shifts", especially in a situation where reality is unstable and full of uncertainties.

Finally, all research is subject to evaluation, and the problems attached to evaluations must also be tackled in relation to research management, which has to be performed with an eye to the expected evaluation of the outcome of research activities. Finn Hansson discusses in his articles the problems and options attached to research evaluations.

Many other issues beyond those presented here have been studied within the REMAP project, which has functioned as an overall frame for studies of research management performed by the REMAP partners and its associates. Not all the projects presented in this report were born as pure REMAP projects, but they have all drawn upon the expertise and knowledge gained within the core project.

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1.2. Science and Society
The Framework of Public Research - Enterprises Relations

Evanthia Kalpazidou Schmidt
The Danish Institute for Studies in Research and Research Policy

Introduction

The position of science has changed in recent years. Together with the emergence of the knowledge-based society the role of science has become more significant and at the same time demands for accountability have increased considerably. This development reshapes the institutional arrangements among universities and research institutes, industries and governmental agencies.

As the role of knowledge production nowadays is perceived and recognised in socio-economic contexts, an increasing number of universities and other public research institutions adjust to the new framework. At the same time governments and policymakers ask for information on the interaction between public research and the private sector, how to evaluate and monitor the relationship and how to establish good practices.

This article discusses the linkage between academia (universities and public research institutes) and enterprises in Denmark, seen from the perspective of the private sector. It highlights some overall features that enterprises are facing co-operating with universities and other public research institutions and describes the framework conditions that influence the relationship between public research and the private sector. The article further points to ways and means to improve the relations.

The main issues discussed in this article are:
- Managers' perceptions of and attitudes on the public research - enterprises relations.
- Barriers impeding more intensive interaction between academia and enterprises - Suggestions on how to overcome the barriers.
- Information and suggestions on general conditions that promote the interaction.

Moreover, the article provides information to policymakers on how to develop framework conditions that can stimulate the interaction.

The analysis is based on in depth interviews with managers of selected prominent enterprises with intensive research activities and experiences from co-operation with public research in Denmark and abroad.

The article is based on a study of managers' perceptions of the interaction between public research and enterprises (Kalpazidou Schmidt 2003b). The study is an integrated part of the REMAP project (R&D Management Processes under Rapid Change) - a research partnership between The Department of Management, Politics and Philosophy (Copenhagen Business School), The Danish Institute for Studies in Research and Research Policy, RISØ National Laboratory and six research based Danish companies. REMAP has an interdisciplinary approach that bridges the gap between theory and application, practice and learning, knowledge accumulation, education and the main institutional actors in the triple helix (the relationship between higher education institutions, industry and government)[1].

[1] For an explicit presentation of the triple helix concept see Etzkowitz & Leydersdorff 1997 & 2000 Leydersdorff & Etzkowitz 2002.

The Changing Framework of Science

As science and research are perceived in their socio-economic context, changes are also taking place among scientific organisations and networks. In this framework new types of relations are created between scientific institutions, industry and governmental bodies that are subject to international debate. The increasing importance of scientific competencies, the increasing emphasis on innovation and the knowledge-based economy together with constraints on public expenditure, have brought changes in the traditional models of funding innovation and R&D. Growing demands for accountability, relevance and value for money for public funding of science are changing the contract between science and society. Science and technology are increasingly becoming strategic resources for companies, regions and countries. The transformation of the science - society relationship has been addressed in a number of publications in the field of science and science policy studies[2].

In The New Production of Knowledge (Gibbons et al. 1994) and Re-thinking Science (Nowotny et al. 2001) the **Mode 2** concept was introduced as a new paradigm for science. According to this, the process of knowledge production and research practice are changing fundamentally. The changes are attributed to the growing contextualisation and socialisation of knowledge. Knowledge is now generated in the context of application.

The implications according to the theory are that science can no longer be regarded as an independent entity, demarcated from society, but depends on how the context within which it operates is defined. A new social contract for science is emerging, as society has increasing demands to research. Science has always provided society with a continuous flow of knowledge on how to conceptualise the physical and the social world. According to Nowotny (2000): ”Mode 2 society generates the conditions in which society is able to `speak back` to science; and that this reverse communication is transforming science. Contextualisation is invading the private world of science, penetrating to its epistemological roots as well as everyday practices, because it influences the conditions under which `objectivity` arises and how its reliability is assessed”.

Within **Mode 1** new knowledge was produced primarily through disciplinary research mainly in universities and academic research institutes. Such knowledge usually had limited connection to societal requirements. Results were transferred to users after the research process was finished. Consequently - according to Mode 2 theory - Mode 1 (in order to preserve maximum autonomy of academia) showed only limited societal accountability.

In Mode 2 a fundamental shift towards a new mode of knowledge production occurs through trans-disciplinary research in a variety of research institutions. This is made in the context of application, and is directly influenced by societal needs with users often involved from the beginning in the knowledge producing process. In this perspective, societal accountability for public funding is central, as changes in knowledge production should be reflected in the public support of research.

However, other researchers claim that there is little systematic evidence that the Mode 2 concept is new[3]. These argue that Mode 2 has always existed and is a complement to publicly funded research but has been intensified during the 1990s. A shift in balance from Mode 1 to Mode 2 concept is so noticed in the last part of the 20th century. According to others[4] the share of Mode 1 in knowledge production has increased, rather than the opposite.

Ziman (1978 & 2000) on the other side describes how science has been going through a structural transition to a more tightly organised, rationalised and managed institution and emphasises the issue of reliability of

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2 See Clark 1998, Georghiou 1998, Etzkowitz & Leydersdorff 2000, Leydersdorff & Etzkowitz 2002, Gibbons et al. 1994, Guston 2000, Nowotny et al. 2001 and Ziman 1994.

3 Compare to David et al. 1999, Martin 2002.

4 See Godin & Gingras 2000.

science in this context. According to Ziman, scientific knowledge can be distinguished from other intellectual artefacts of human society by the fact that its contents are *consensual* (asks for a maximum degree of agreement) and *consensible* (is comprehensible to others). Through the operation of the dual processes of consensibility and consensuality within the relevant peer group, science becomes able to produce reliable knowledge. In accordance to this epistemological model, science produces reliable knowledge if the rules - which guide research practice - are followed. Ziman argues that Mode 2 (as Mode 1) may also incorporate traditional scientific values. However, Mode 2 research is an activity where socio-economic power is the final authority, according to Ziman (2000).

From the literature on science and the European, national and regional policy agenda it looks like the whole system of knowledge production is in transition with constant reorganisations of relations between various actors and sectors[5].

Etzkowitz & Leydesdorff (2000) claim that one effect of the reorganisations and the networks linking academia, industry and government is on science itself. Science is changing as a result of internal processes within academia strengthened by policymaking. Normative changes have taken place not only as a result of the emergence of an entrepreneurial culture within academia but also from external influences on the university. Etzkowitz & Leydesdorff (2000) and Benner & Sandström (2000) argue that research funding and research funding organisations create “organisational fields” that over time affect the routines, norms and organisational structures of researchers and their institutions.

Hence, some fundamental questions arise: if the production of knowledge is changing (as Mode 2 theory claims) that must imply that scientists are changing in their behaviour and attitudes too. If the interaction between science and society is in transition from Mode 1 to Mode 2, then the private sector as well as policymakers and funding agencies are changing in their attitudes and practices. If universities are changing in the process of interaction with other sectors and actors, the private sector is also changing in order to meet the demands of the new environment. A central question is accordingly whether this is a new mode of knowledge production and new ways of academia - private sector collaborations.

The debate on this issue has consequently raised questions such as: is it plausible to orchestrate the interaction between academia and the private sector? If this is the case, what may then be the instruments to achieve this[6]?

In order to find answers to these questions, attention has been given in this article to the viewpoints of the enterprises on the public research – enterprises relationship in Denmark. Moreover, it has been identified what is required in order to increase communication, networking and collaboration between academia and enterprises.

Public Research – Enterprises Relations in Denmark

In Denmark, industry has traditionally been present in the overall RTD and innovation system[7]. However the resources used on RTD activities in industry show great differentiation with regard to sector and size of company. Even the extent of collaboration between the private sector and public research institutions shows differentiation. Larger RTD intensive companies with established research departments have more interaction

5 Theories on "national systems of innovation" (Lundvall 1988, Nelson 1993), theories on "research systems in transition" (Cozzens et al. 1990, Ziman 1994), Mode 2 theories and theories on "the post modern research system" (Rip and Van der Meulen 1996) are indicative of the changing role of knowledge in socio-economic systems.

6 Linkages between the public and private sector has become an issue for policymakers and concentrated efforts to find a more effective utilisation of science and technology results (for an explicit presentation of the development in science policy at European level see Science Policy, Setting the Agenda for Research, Managing with Uncertainty in Science Policy, Proceedings from MUSCIPOLI Workshop One 2001 and Building European Capacity. Proceedings from MUSCIPOLI Workshop Three 2003, OECD 2002 and Polt et al. 2001).

7 See The Danish Institute for Studies in Research and Research Policy 2002/14 and 2003/5.

with universities and other public research institutions (Graversen et al. 2003).

Recent quantitative research in the field confirms that private enterprises with well-established collaboration with public research benefit from this, as they have a series of competitive advantages compared to those without. RTD activities for these enterprises are evidently less costly and more efficient[8]. A study of perceptions of 600 managers of private businesses on the issue of public research produced in Denmark, and the significance of this research for their enterprises, reveals that approximately 40% consider knowledge from public research institutions of importance. Nearly 60% of these enterprises (those with actual collaboration with public research institutions) point out that the knowledge produced with public funding is of importance for the companies. This group of managers consequently request a strengthening of ties with public research, more information on research from public institutions and a strengthening of public research in general[9].

These findings are supported by other studies, which conclude that research managers and researchers at universities and public sector institutes in general have a positive attitude to increased co-operation with enterprises (Graversen et al. 2002, Langberg & Lauridsen 2001, Lauridsen 2002). A recent study of dynamic and innovative public research environments in Denmark illustrated that by far the majority of these environments had established networks and co-operation with the private sector (Graversen et al. 2002, Kalpazidou Schmidt et al. 2003).

Consequently, the above-mentioned studies have confirmed the interaction between the private (although mainly larger companies) and the public sector. They have also illustrated the positive attitudes of public researchers towards co-operation with the private sector. The main issue is hence to find reasons for absence of more widespread interaction, potential barriers and how to overcome these.

OECD studies (1999 & 2002) reveal that for the majority of the countries involved, there are only parts of the industry that have established co-operation with parts of the university system. The linkage is stronger in certain countries than in others. Focusing on Denmark, it is concluded that the linkages between Danish industry and Danish universities were not as strong as in other OECD countries in this respect. Denmark held the 24th position among 28 countries (OECD 1999).

In addition, the Danish *university system* is under-financed compared to other systems in OECD countries with equivalent income levels (OECD 2000). Denmark spends less than half of the resources per student compared to the US and 2/3 of the resources spent in Sweden. The share of *government funds* in total R&D support in Denmark is though higher than in the countries mentioned above (OECD 2002).

Focusing on the Danish innovation system Lundvall (2001) argues that it is characterised by:

- An overrepresentation of small firms and few big companies (seen in an international perspective).
- A specialisation in products that have very low R&D content.
- Large number of small- and medium-sized companies, many with few or no capabilities with academic background.

Danish companies in all sectors are innovative with respect to products, processes and organisation (the small countries paradox). Innovations have their origin in new knowledge that is mainly produced abroad. Moreover innovations in Denmark introduce products that are not new, seen in an international perspective. Competences are built up in companies based on broad experiences and through intensive co-operation with national and international companies, costumers and suppliers (Lundvall 2001).

8 The Danish Institute for Studies in Research and Research Policy 2002/14.
9 The Danish Institute for Studies in Research and Research Policy 2002/3.

This evidently does not describe the entire picture of the Danish innovation system. Recent studies on innovation among 600 Danish companies reveal that more than every third company is innovative, a fairly high number[10]. This implies that enterprises in focus have - during a three-year period - developed a new product, significantly improved products and/or have radically reorganised one or several of production processes.

As far as innovation concerns and in comparison with other Nordic countries, Danish enterprises are on level with Swedish and Finish companies and over the level of Norwegian enterprises. Especially in high technology companies (medical industry included), but also within the knowledge intensive business sector, there is a substantial knowledge-based innovation system. Larger enterprises are as a rule more innovative. Consequently, more than half of the enterprises with more than 50 employees are innovative. Among high-tech enterprises, and in the knowledge intensive business sector, the figures are remarkable high namely 9 of 10 are innovative.

The total amount of expenditures for innovation activities in Denmark was in the fiscal year 2000 approximately 43 billion DKK. The highest innovation intensity (assessed as innovation expenditure in relation to revenues) was found within the knowledge intensive business sector (15%) and among high-technology companies (9%), while the average intensity was approximately 6%.

Studies point to the fact that barely half of the companies surveyed have used knowledge produced in public research institutions for innovation purposes. In addition, 40% of the sample is co-operating with others in innovation processes. Co-operation partners are found primarily among suppliers and costumers. One in four companies co-operates with universities and other public research institutes. Of the companies engaged in collaboration with public sector, Danish partners dominate the picture. At the same time, it is seen that roughly half of the studied enterprises co-operate with foreign companies. The additional innovation comes from knowledge produced in the same company, in other companies or knowledge that employees get in connection with fair visits and from scientific journals (Graversen et al. 2003).

This is the framework for the Danish industry - public science relations. According to Lundvall (2001), the reason for not being able to establish a more organised and intensive relationship is the fact that the private sector has only modestly requested Danish produced scientific knowledge in the innovation process.

It is acknowledged that the interaction of industry with public research institutions is greater with some universities than others. In this respect even historical circumstances, such as the orientation of Polytechnics towards mainly academic science already from its foundation, could be of significance for the establishment and further development of the relationship (Wagner 1998).

Focusing on the type of knowledge used, companies point out that social sciences and humanities are of high or very high significance for their enterprises too[11]. Focusing on differences between sub-sectors, the same study concludes that the knowledge intensive business sector, which demonstrates the highest innovation intensity, and the finance sector point out that social science and the humanities are the most important for the development of their companies' knowledge reservoir.

Another feature characterising the Danish innovation system is the existence of consulting institutes (GTS-institutes, engineer firms and management firms) that function as bridge-builders between research and enterprises, and which operate on terms comparable to the private sector. The function of these institutes is to facilitate communication with the private sector and accordingly to smoothen research processes and co-operation activities.

[10] The Danish Institute for Studies in Research and Research Policy (Graversen et al. 2003).

[11] See the quantitative study of 600 companies undertaken by The Danish Institute for Studies in Research and Research Policy (Graversen et al. 2003).

Public Policy Initiatives

In recent years a system of policy instruments has been introduced in Denmark that guaranties public support to new co-operation initiatives (contracts, innovation environments and science parks, mobility programmes and exchange of researchers' programmes). This effort aims to overcome barriers that impede interaction between public research and the private sector.

The debate on the principles of research funding in Denmark is ongoing. New governmental initiatives led to a reorganisation of the supporting and financing structures of the RTD and innovation system. At the same time, a new legislation on the governance of universities was introduced with increased private sector representation at the governing board level. Recently, the Danish government presented a plan aimed at stimulation of the relationship between universities and the private sector and at facilitation of the interaction, especially targeting the small- and medium-sized companies. 275 million DKK were earmarked for this purpose (2004-07). In addition, universities have given room for establishing separate entities to promote such interaction at market premises. Consequently, the general framework for a closer relationship between public and private research is more favourable than ever.

The situation with respect to public – private co-operation in Denmark is not fundamentally different from other countries with high R&D intensity and well-developed infrastructures. The interaction between small- and medium-sized companies and public research has, according to recent research[12], increased considerably during the last years. However, the fact that only 3% of the enterprises have an actual co-operation with public research institutions highlights the need for persistent efforts to continuously improve the framework for research interaction.

A recently published report[13] shows that Denmark is not among the top seven innovative countries. The investigation uses as criteria research funds, utilisation of research results, and the framework conditions for innovation activities. The results show that - seen in a comparative perspective - commercialisation of research results is not developed and only a limited amount of public research funding is used for financing of research co-operation between different sectors. Denmark is lacking also regarding research-based companies that are spin-offs from universities. Managers express that they have limited access to technology, both in terms of technology produced in public service- and patent systems, and the one produced in private companies.

However, new technology transfer structures and intellectual property policies have been introduced. Laws and policies governing the ownership of intellectual property policies at universities and other public research institutions are being scrutinized in Denmark, as in other OECD countries, with a view to encouraging ownership of inventions by the institution producing the research. Legislation has been introduced to grant universities title to intellectual property rights that emerge as a result of public funding. The Act on Inventions at Public Research Institutions (initiated in 2000) grants title to such institutions but allows the inventor right of first refusal. In addition a Consolidated Act on copyrights regulates ownership of literary and artistic works. Copyrights at public research institutions are governed by the same rules that govern copyright ownership in the private sector. The government, as one of few among the OECD members, has also developed national guidelines related to conflicts of interests involving researchers and intellectual property activities (OECD 2002).

Denmark, like other OECD countries, is experimenting with regional or sector-based technology transfer offices and management of technology transfer activities for several public research institutions. In addition, legislation provides direct and indirect support, although on a time-limited basis, to help universities and other public research institutions cover costs associated with patenting and commercialising inventions.

[12] See The Danish Institute for Studies in Research and Research Policy 2003/ Forskningsstatistik 2001.
[13] Nyholm & Langkilde (2003).

Indirect support in form of decreased patent application expenditures for universities on the one hand and informational and awareness shaping measures on the other, have also been implemented.

Before the introduction of the law on intellectual property rights, only the University of Aalborg (that is technically oriented and mainly active in regional technology transfer supported by EC regional policy for "peripheral districts" in EU member states) as one of the twelve Danish universities had an office that dealt with technology transfer. In the late 1980s, other universities and a few university hospitals established embryonic industrial/external liaison offices. These primarily gave advice on applications for external funding. Some of the government laboratories have had technology transfer offices since the late 1950s. In the 1990s some university hospitals developed liaison offices in the direction of technology transfer offices. However, this was not a general tendency in hospitals at the time (Milthers 2002).

In Danish universities and research laboratories, technology transfer offices in non-university based public research institutions are organised as a division of public research offices, but are not specifically dedicated to technology transfer. The question is hence whether there is an optimal institutional arrangement for technology transfer offices in the Danish RTD and innovation system (OECD 2002).

Innovation policy in Denmark has primarily focused on improving conditions for enterprises with respect to better funding possibilities, public financial support for professional advice on management, recruitment, marketing and patenting. There is a programme though linking higher education and enterprises, the industrial PhD programme that provides enterprises with a possibility of refunding half of their expenditures for PhD students working on their thesis in a company (supervised by university professors). The legislation, in force since summer 1999, prioritises the role of public research institutions in the innovation system and the responsibilities stemming from participation in this (Milthers 2002).

Policies implemented by legislative or other means have proved effective in some OECD countries. One main impact has been to raise awareness of and support technology transfer from public research institutions, particularly within the administration and among researchers and graduate students. Although identical approaches to technology transfer are not appropriate for all countries (due to differences between public research institutes and their role in national innovation systems) the impact of raised awareness among stakeholders is crucial. There is though some concern that different national legislations in EU member states may create obstacles to collaboration and may impede the highly required synergy effect at European level (OECD 2002).

The earlier mentioned studies on Danish innovation activities (Graversen et al. 2003) underline the importance of research policy initiatives. In general, enterprises with intensive R&D activities estimate the significance of such initiatives as high compared to other innovative enterprises with no R&D activity and non-innovative enterprises. 10% of all enterprises indicate that policies have no implications at all. The first group of enterprises (with a high degree of co-operation with public research) has a very positive attitude to public research in general and asks for increased resources to public research. In addition, managers of innovative companies more often claim that changing organisation and management of universities (introduced recently by the government) could be a significant research policy initiative (see table 1, adopted from Graversen et al. 2003).

Table 1. The significance of research policy initiatives. Percentage

Share of managers estimating that a range of research policy initiatives have a high or very high significance			
Research policy implementation	R&D intensive companies	Other innovative companies (no R&D activities)	Non-innovative companies
Increased funding to basic research	46	42	45
Increased resources to PhD programmes	46	48	41
Increased funding to public research in general	61	54	52
Increased funding to specific fields/co-operation			
Increased funding to specific fields such as IT, bio-technology, energy supply and health	48	52	41
More funds to be distributed through the EU framework programme for research and technology	31	19	21
Increased funding to specific fields/ co-operation in general	59	52	44
Increased funding to enterprises	50	49	45
Changed management at universities	42	50	24

A classification of the above-mentioned enterprises in sub-sectors illustrates the variation in attitudes between different sub-sectors. Many enterprises, especially within the knowledge intensive business sector, underline the importance of more funding for public research. However, knowledge intensive companies are not in favour of a change in the university management system. This is the position though of the manufacturing industry which at the same time points to the importance of increased funding levels for enterprise research (Graversen et al. 2003).

For a majority of companies, some public policy measures to support R&D activities have not had a strong impact on their prospects to RTD and innovation activities (see table 2, adopted from Graversen et al. 2003). Direct subsidies, such as subventions and tax regulations are measures that managers (especially managers of R&D intensive companies but also those of other innovative firms with no R&D and of non-innovative companies) perceive as the most important. The next most important measure in this context is public funding to R&D activities at universities and research institutions and programmes to stimulate co-operation among companies and with public research institutions. Mainly among the R&D intensive companies is this perception common. Non-innovative companies are also well represented here. This (seen together with the need that companies have for more information programmes and info-centres) implies a request for governmental assistance in order to start-up activities.

Table 2. The significance of public supporting measures for enterprises possibilities to research and development. Percentage

Share of enterprise managers estimating public supporting measures as being of high or very high significance			
Measure	R&D intensive companies	Other innovative companies (no R&D activity)	Non-innovative companies
Subsidies (tax regulations, subventions etc.)	21	18	14
Public funding to R&D at universities and research institutions	18	3	7
Programmes to stimulate R&D co-operation among companies or between companies and research institutions	16	3	12
Information programmes or programmes supporting technical development	13	3	8
Public purchase	10	9	10
Assistance in relation to patent application	7	0	4
Centres that gather technical information on innovation in other countries (Info-centres)	5	5	7

Perceptions of Public Research

Different perceptions of the function and role of public research and universities, their objectives, strategies, management and instrumentation persist among managers of enterprises. They describe obstacles to co-operation and offer suggestions as to incentives and instruments that can be used to facilitate the relationship and intensify exchange of knowledge. Research policy issues are consequently high on the agenda of managers.

The results presented in the following - seen in the light of the literature on science – industry relationships and earlier research[14], give an extensive illustration of the subject in focus. The results are of relevance to the debate on research and science policy and efforts to achieve synergy between the three sectors in the RTD and innovation system i.e. public research, the private sector and government (Kalpazidou Schmidt 2003b).

Managers perceptions of and attitudes on the public research – private sector relationship reveal that:

- Parts of some universities and public research institutes have established an intensive interaction with parts of the private sector (mainly larger companies).
- The more experience companies gain from research co-operation with universities and other public research institutions the more positive are attitudes and perceptions on the interaction.
- The larger and more science- and research-based the company is (with a high proportion of research input out of the total input) the more intensive is the interaction with universities and other public research institutions.

[14] Compare to Georghiou 2001, Howells et al. 1998, Polt et al. 2001 and OECD 2002.

- Enterprises - especially the small- and medium-sized companies - have difficulties in getting information on public research (information on know-who and know-how).

- Enterprises with little or no experience from interaction with universities and other public research institutes have difficulties in overcoming the barriers and in establishing a co-operation. This is characteristic of the small and medium-sized enterprises that are not science-based and have few or no capabilities with academic background.

- Attitudes towards the public research-private sector relationship vary dependent on characteristics of the market actors and the composition and structure of the private sub-sector on the one side and the public research on the other. In general, attitudes among small- and medium-sized companies are not particularly positive due to lack of compatibility of knowledge and knowledge asymmetries, lack of information on the knowledge reservoir and lack of absorption capacities.

- There are considerable differences in the perception of research objectives of public research institutions and universities on the one side (many engaged in long-term, basic research activities) and those of the private sector on the other (have as a rule short to medium term objectives and are product oriented with the exception of larger science-based companies).

- The perception of strategies and instruments used in public research varies among managers. Two main categories have been identified. The majority of managers consider strategies and instrumentation in public research as different from those used by companies due to differentiation in objectives, demands on markets, market mechanisms and competition. Others find that contemporary universities adopt strategies and make use of similar instruments like in private sector in order to continue to attract funding in a highly competitive environment.

- Enterprises and public research institutions use a variety of channels (some formal and/or mainly informal communication and contacts are used) in the interaction process.

Barriers for Intensive and Widespread Co-operation between Public Research – Enterprises

Barriers that impede closer linkage between the enterprises and public research institutions have been identified. These may be structural or contextual, but also of institutional and/or of legislative and regulative character. Barriers can also be rooted in prejudice, misunderstanding or lack of interest for each other's point of departure, cultures and practices, norms and values. The main barriers – seen from the private sector perspective - are summarised below:

Structural and contextual barriers

- Difficulties in getting information on public research and the existing knowledge reservoir
- Difficulties in matching knowledge supply and demand
- Information asymmetries (open public research versus closed private sector and low market transparency)
- Different and in many cases incompatible objectives
- Uncertainty of outcome in public research – high-risk research/large spill-over.

Institutional settings

- Public domain mentality of universities (bureaucracy, "ivory tower", inefficient organisation and long-term perspective research)
- Bureaucracy and inflexibility of administrators and researchers

- Poor university marketing/technical/negotiation skills and marketing orientation
- Lack of university resources to research and technology transfer
- Universities are too aggressive in exercising intellectual property rights (especially as to publication).

Legislation, regulation and policy

- Lack of motivation and reward mechanisms for public researchers with respect to engagement with companies
- Lack of capabilities at universities that the private sector can utilise
- High transaction costs from companies to university – financing restrictions.

Differentiation in cultures, norms and values

- Divergent cultures and objectives
- Universities are closed systems that are not interested in co-operation
- Lack of understanding regarding corporation, business and commercialisation of research results at universities
- University researchers do not understand corporatism and are not interested in understanding it
- Universities are not interested in business and commercialisation of research results
- Universities are bureaucratic and their inefficient, inflexible organisations impede co-operation with companies
- Only some fields (limited in numbers) are of interest for the private sector
- The perception of time and pace in the activities is different in the two cultures (public research is slow and time consuming)
- Public researchers have unrealistic expectations regarding the value of their research
- University researchers are driven by curiosity and interest, while the bottom line in the enterprise culture is revenue.

In an international perspective, such barriers are not merely characteristics of the Danish entrepreneurial scene but are common features in other countries too[15]. As regards the situation in Denmark in particular, five main features may be subject to specific research policy initiatives:

- Lack of information on public research that the private sector can utilise

- Lack of capabilities that the private sector can utilise

- Lack of communication (and informal contacts) that can improve understanding of the cultural and normative settings

- Lack of incentive structures and institutional settings in public science that can motivate researchers and facilitate interaction with the private sector

- Lack of possibilities for absorbability of research by small- and medium-sized companies with few or no academic capabilities (a feature that characterises the Danish private sector in general).

Public policy promotion programmes such as the PhD and research exchange programmes introduced by the government as well as intermediary structures, such as the newly launched database and information network aimed at fostering the industry-academia relationship, provide additional resources, and improve the physical and immaterial infrastructure. Moreover, programmes are introduced (such as a new think-tank on public awareness) to raise awareness on the role of science in society (which already is high in Denmark) and develop more positive attitudes towards science and change behaviour.

[15] Compare to Georghiou 2001, Calvert et al. 2003, Howells et al. 1998, Polt et al. 2001 and OECD 2002.

Lack of human resources is another key issue to put attention on. Higher education and research policy may focus on training and mobilising human resources required by the private sector as well[16].

Suggestions for Improvements of the Relationship

The following subjects could be taken into consideration in order to improve co-operation between the private sector and public research institutions. Seen from the private sector perspective and according to managers of enterprises the universities should:

- Educate staff better in order to overcome informational and cultural barriers
- Build capabilities that enterprises can use
- Devote more resources to research and technology transfer to industry
- Develop a system providing easy access to public research knowledge reservoir (access to know-how and know-who) and indicate how collaboration can be established
- Develop systems, mechanisms and expertise to handle research and technology transfer
- Develop a more forceful market orientation and marketing skills
- Give increased attention to fields of science of high economic importance
- Develop a higher degree of strategic planning adjusting to the economic development in the country
- Improve management and leadership of research
- Increase networking between public researchers and the private sector
- Improve reward systems for research and technology transfer activities
- Increase motivation among public researchers for co-operation with the private sector
- Be less forceful in exercising intellectual property rights
- Be less forceful in exercising publication rights
- Universities and companies should devote more efforts to develop mutual understanding and establish informal contacts.

Companies on the other hand (particularly small- and medium-sized) should upgrade their organisations and adjust processes and production to demands of the new socio-economic environment.

Incentives for more Effective Interaction

A central issue for actors in the RTD and innovation system are incentives. Stimuli for the private sector and public research institutions to co-operation may be augmented with respect to:

- Knowledge on knowledge
- Mutual learning (through teaching, training, conferences, workshops, visits)
- Access to knowledge (know-how and know-who) and technological problem-solving
- Exchange of coded and tacit knowledge
- Access to complementary RTD and innovation resources (also co-financing/sponsoring of postgraduate and doctoral students)
- Establishment of intermediary structures such as centres, embedded laboratories, networks, companies designed for the purpose that can be of significance in a long term perspective
- Access to specialised equipment
- Personnel training and mobility (public researchers, PhDs and Masters, taking up employment within enterprises. Industry researchers taking up employment in public institutions or establishing of joint laboratories)
- Establishment of knowledge networks (informal and formal) and clusters
- Building capabilities
- Elimination of competition and tensions (arising from universities commercial activities) between universities and industry

[16] Graversen et al. 2003 and Kalpazidou Schmidt 2003b.

- Limitation of the uncertainty in research processes and outcomes
- Achievement of synergy effect.

Public policy can be a mediator in the process of establishing cross-sector linkages. Policy can set the legislative rules and improve institutional frameworks to provide incentives to public research institutions and researchers, and promote cross-sector co-operation. Consequently, the following are important policy issues for the RTD and innovation system in general:

- Matching supply and demand of scientific knowledge
- Improving the responsiveness of public research to emerging needs of enterprises
- Training and mobilising human resources
- Promoting the participation of small- and medium-sized companies in the RTD and innovation process.

Science policy can use instruments such as funding mechanisms, evaluation and assessment of publicly funded research and benchmarking to achieve objectives of the RTD and innovation system[17].

Some of the instruments already used in Denmark are *The Danish Industrial PhD programme* and *The Danish Investment Fund*[18]. The attitudes of 600 managers to these policy instruments expressed in terms of utility and/or aspiration to utilise them is illustrated in table 3 (Graversen et al. 2003).

Table 3. Companies use of /aspiration to make use of specific policy instruments. Percentage

Policy instrument	R&D intensive companies		Other innovative companies (none R&D activity)		Non innovative companies	
	Have made use of	Wish to make use of	Have made use of	Wish to make use of	Have made use of	Wish to make use of
The Danish industrial PhD programme	22	17	0	19	1	7
The Danish Investment Fund	10	31	0	46	0	21

Only companies with R&D capacities have made use of the policy instruments in question. Other innovative firms (without R&D activity) expressed a wish to make use of the Danish Industrial PhD programme and, to a much higher degree, of the Danish Investment Fund. Furthermore, nearly half of the larger companies (with more than 250 employees) make use of the industrial PhD programme.

In addition, the importance of different public policy instruments for companies has been subject to investigation in the quantitative study of Danish enterprises[19]. Increased public funds to enterprise research and more funds to specific targeted areas such as IT, biotechnology, energy-supply and health are important public policy supporting measures as table 4 illustrates.

[17] For a discussion of science policy instruments see Building European Capacity. Proceedings MUSCIPOLI Workshop Three. AFSK 2003, Kalpazidou Schmidt 2003a and Siune & Kalpazidou Schmidt 2003.

[18] The Danish Investment Fund is a state owned financial company, operating independently in the capital market. It facilitates the supply of venture capital in terms of start-up equity and high-risk loans. The fund invests in private venture funds specialising in specific industry sectors and in companies whose business ventures are innovative and have a high growth potential.

[19] Graversen et al. 2003.

Table 4. The significance of different public policy supporting measures. Percentage

Share of enterprise managers estimating some public policy measures as being of high or very high significance			
Public policy supporting measure	R&D intensive companies	Other innovative companies (none R&D activity)	Non innovative companies
More public funds to enterprise research	50	49	45
More funds to targeted areas such as IT, biotechnology, energy-supply and health	48	52	41
More funds to be distributed through the EU framework programmes for RTD	31	19	21

Managers perceive specific public policy incentives and supporting measures to encourage co-operation in the innovation process, such as *access to public research institutions knowledge and competence* as being of great importance for their activities (see table 5, based on Graversen et al. 2003). This is the case particularly for companies that have established co-operation with public research institutions. The share of managers that claim that *achieving increased commercial success* due to co-operation with public institutions is of importance for their companies is high too. *Limit technical risks and uncertainties in research processes* are also perceived as an essential impact of their co-operation with public research.

This illustrates the confidence that managers of enterprises have in public research. It strengthens the results of the qualitative study where the managers point out their confidence in public research[20]. It supports also statements by managers that the more contacts to public research the more positive are the attitudes and perceptions of the interaction.

[20] Kalpazidou Schmidt 2003b.

Table 5. The significance of public policy incentives and supporting measures for co-operation in the innovation process. Categorisation in types of partnerships. Percentage

Share of managers estimating incentives or supporting policy measures as being of high or very high significance								
Incentives /supporting measures to encourage co-operation	Co-operation partners							
	Companies		Public Research institutions		EU-countries		Non EU-countries	
	Yes	No	Yes	No	Yes	No	Yes	No
Incitements								
Access to other companies knowledge and competence	62	51	66	52	62	51	67	52
Limit technical risks and uncertainties in research processes	45	47	47	46	45	47	50	44
To achieve increasing commercial success	57	53	59	52	55	54	61	52
Have someone to share the expenditure with	32	56	36	45	33	57	31	49
Increased opportunities for public funding, EU funding included	19	37	23	28	20	36	12	35
Supporting measures								
Information programmes or programmes supporting technical development	13	9	17	8	13	9	15	9
Programmes supporting co-operation on R&D; private-private or private-public	18	8	24	8	19	7	20	10
At least one of the above mentioned options	84	80	91	78	83	80	86	80

Implications for Research Policy

Framework conditions influencing the public research - private sector relationship should be considered in a policy perspective. It is important to keep in mind that the private sector-public science relationship is only one element of the RTD and innovation system. It should therefore be studied and understood in the context in which it operates. This has to be the starting point also for research policy initiatives aiming to shape framework conditions that stimulate the exchange of knowledge and technology.

Some features of significance for research policy have been derived from the study[21]:

- Policy initiatives should have as point of departure the characteristics of the market and the institutional framework of public research.

- Policy initiatives related to public science-private sector relations should be accurate, comprehensive and have a long-term perspective. Such initiatives need a long time in order to achieve changes in structures, but also in actors' attitudes and behaviour.

[21] For a comprehensive presentation of the study, its theoretical and empirical background see Kalpazidou Schmidt 2003b.

- Policy initiatives should aim to limit fragmentation and derive synergies in the RTD and innovation system.

- Initiatives should be taken aiming to open up dialogues between enterprises and public research and establishing formal and/or informal communication channels and platforms. There is a need for creation of a framework that facilitates informal contacts as well.

- Policy initiatives targeting public research in specific fields of strategic significance for the socio-economic development should be encouraged.

- Engagement of small- and medium-sized companies in efforts to increase use of public research in the private sector. Companies lacking absorption capacities and capabilities to make use scientific knowledge should be supported. Specific measures and incentives targeting these companies could influence attitudes and practices.

- Engagement of small- and medium-sized companies with sufficient ability and absorption capacities should be encouraged and motivated to take initiatives related to public research activities. Incentives should be introduced to this area.

- Common research programmes that support co-operation, especially thematically focussed programmes with a bottom-up approach and long-term perspective could prove effective and sustainable.

- Establishment of new/ increased support to existing infrastructure, institutions and facilities that can be managed both by companies and public research simultaneously, and which may become a basis for long-term collaborations (that continue beyond the support from public funding).

- A competition-based approach of resource allocation related to co-operative research programmes can stimulate a larger number of joint (public-private) project applications. Those that get funding at the end of the selection process may serve as good practice for others.

- Initiatives and incentives that raise awareness among public researchers on the commercial potential of their results, particularly in fields of strategic interest for the RTD and innovation system should be encouraged.

- Adjusting the institutional framework of public research to collaboration activities.

- Establishment of an effective infrastructure in public research that supports co-operation with the private sector and facilitates knowledge transfer.

- Establishment of specific institutes at universities and/or in public research institutes specialised in knowledge transfer. Such specialised institutes could - on a regular basis - adjust research strategies to changing environmental conditions and transfer knowledge direct to companies without interfering mediators.

- Adjust the framework of public research in order to provide institutional and individual incentives and rewards (in connection with evaluations of both individual and institutional activities).

- Encourage increased mobility between the private and the public sector, exchange and educate researchers and personnel (promoting informal visits to each other). Increase education programmes tailored for researchers in the private sector at universities and public research institutions. Intensify temporary mobility.

- Building capabilities that enterprises can utilise.

In conclusion, and in order to stimulate closer co-operation between public research and the private sector, research policy may consider particularly the market and identify successes and failures of it. Research policy should be based on a comprehensive knowledge of the public research institutions, their organisation, function, activities and their role in the RTD and innovation system. Companies on the other side should consider their position in the future RTD and innovation system in a rapidly changing framework.

Concluding Remarks

Generation and utilisation of science in RTD and innovation systems has in recent years been the subject of increased societal attention. As society "speaks back" to universities setting growing demands for accountability and societal relevance of research outcomes, research universities are facing problems of legitimation. In this context, traditional research universities are going through a transformation process. Out of the dialogue between science and society, new types of universities are emerging that are untraditional in their mode of defining research processes and production, evaluation of results and reward mechanisms, as well as communication and dissemination of results. Hence, the interaction between academia and society has been intensified. The private sector is one significant actor in this interaction, policymaking another.

One precondition for a fruitful collaboration between public research and private sector is mutual respect and understanding of the framework that the two sectors operate within (and respect for the cultural settings in the sectors). Likewise the interaction depends on the absorption capability of companies and their ability to interact with universities and public researchers. The interaction further depends on the degree of awareness among public researchers on possibilities of co-operation and the awareness among companies of the potential benefits of collaboration with public research. Hence, policymakers can function as mediators.

In response to new demands of the socio-economic context, evaluations of research should be modified. This implies that consideration should be given to criteria for advancement and funding in academia. The question is whether advancement should comprise solely traditional academic performance or should it be complemented with other criteria (such as interaction with other actors in society as well).

Research policymaking also has to take into consideration that the more uncertain the research tasks, the harder it is to attract private sector funding. Accordingly policy has to reflect that not all research is of immediate utilisation, nor can it always directly match narrow societal requirements or the instant needs of enterprises. It is therefore of importance to pay continued attention to basic research and scientific fields that are of no direct commercial interest. This should be done in order to limit risks of overlooking potential innovative research.

In addition, research policy has to take into consideration that some measures to make public research more “private sector oriented” involves restricting of the amount of knowledge available to other researchers, at least for some time. In general, policymakers should bear in mind when forming research policy that while greater interaction is definitely to prefer, there may be some risks involved in increasing the interaction and as a consequence favouring more applied approaches in public research. The risk is again to overlook future innovation and what may be beneficiary for the society as a whole.

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Chapter 2: Science policy as a Challenge for Research Management

2.1. Managing with uncertainty in science policy

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Abstract

The EU funded Muscipoli project with the full name “Managing with uncertainty in science policy” highlights the challenges to science policy and emphasizes the management problems given the uncertainty in science policy.

Among the challenges are the uncertainty about human resources, the increasing role of multinationals and transnational funding while we find a decreasing role of national funding and at the same time we see an increase in the number of actors and principal agents relationships. In addition to these challenges there is a growing demand for research to show societal impact! How to manage at different institutional levels given these challenges and the uncertainty attached to the situation and specifically attached to science policy?

The conclusions from the Muscipoli project are particularly relevant in REMAP context as far as they present the European element in The Danish Institute for Studies of Research and Research Policy’s work centered around research management .

Managing with uncertainty in science policy

Science policy defined as “*the collective measures taken by a government in order, on the one hand, to encourage the development of scientific and technical research and, on the other, to exploit the results of this research for general political objectives*” is a relatively new field of government responsibility. It is only in the last 50 years, that this field has been given institutional recognition through bodies, mechanisms, procedures and a bureaucratic and political staff specifically concerned with these questions (Salomon, 1977,43-46).

In these 50 years of existence, the design of science policy has seen a lot of changes of which some of the most fundamental have been observed in the last couple of decades. The changes have been thematic, operational and structural, and in the theoretical literature it has been almost commonplace to emphasize how the relationship between science and society has changed dramatically during this period. These developments have been addressed in a number of recent contributions to the field of science policy studies (Elzinga & Jamison, 1994; Gibbons et al. 1994; Ruivo, 1995; Guston, 2000 etc.). In these and other contributions it has been emphasized, how the design of science policy since World War II has gone through a number of phases or paradigms, and how the political doctrines have changed accordingly.

Even though there are disagreements in the reviewed literature concerning the distinction between the different paradigms or phases, and even though opinions differ as to which issues are considered most important and deserve to be highlighted, the bottom-line in all contributions are, that the design of science-policy has changed significantly in the last couple of decades.

It is claimed, that these changes have become manifest in all aspects of the science-society relationship, and have affected everything ranging from institutions and disciplines to practices and policies. Among the most influential are the claims, that the process of knowledge-production is changing fundamentally (Gibbons et al., 1994, 2001); that the organization and functioning of the overall research-system is changing (ex. The triple helix-literature); and that a new social contract for science is emerging, as the political system and the society in general are increasing the demands to the research system.

Along the same lines John Ziman has described how science has been going through a radical structural transition to a much more tightly organized, rationalized and managed social institution. According to him, this transition to quite a new regime started in the mid-1970s, and is still going on. The same forces for change are at work everywhere, and many of the same features have emerged in many countries. His central argument is, that there is no way back to the traditional way of managing the business of research, but there is also no obvious path forward to a cultural plateau of comparable stability. The challenge is therefore to understand properly what is happening to science. He claims that realistically, the most we can usually do, is to try to understand how an effective research system actually functions, so as to make sure that essential functions are not impeded as a result of seemingly harmless organizational change (Ziman, 1994, 249-250).

In spite of this fundamental lack of knowledge the design and management of science-policy is still rapidly changing in most countries, even though the consequences of these changes remain highly uncertain. Uncertainty has always been an inescapable part of the management of science policy, but this uncertainty seems to have become a growing factor for science policy makers, as the traditional foundations for science policy increasingly have been questioned during the last decades of science policy research. The traditional relationship between politics and science is to a higher and higher degree being set aside, but it is strongly debated if and how it should be replaced.

The MUSCIPOLI-project

The management of science policy is rapidly changing and the long-term consequences of the use of new and different forms of organisations, institutions, instruments, processes and procedures are still to a large degree unknown. As an attempt to reduce this growing uncertainty in the design and management of science policy the MUSCIPOLI project was launched. MUSCIPOLIS aim has been to provide practical insights and develop improved concepts for the understanding of the science-policy decision-making and its outcomes. MUSCIPOLI seeks to improve the understanding and management of the various complex links between science policy aims, policy-making and downstream scientific activity, output and impact.

The first activity within this STRATA Accompanying Measure was to facilitate critical comparative discussions of a selected number of science policy aims or priorities and associated scientific activities at the European level and in a variety of national contexts. These comparisons have been made at a series of international workshops, which will address the design and delivery of three different types of science policy issues, namely thematic, operational and structural issues. *Thematic issues* deal with the content of scientific activity, prioritising particular disciplines, fields and/or applied areas of research and technological development such as environmental sciences, information technology, health care, etc. *Operational issues* specify the way in which scientific activities should be performed by emphasizing principles such as inter- or trans-disciplinarity and academic-industry linkages. *Structural issues* concern the optimal functioning of the system and include, for example, the need to develop a new academic generation, to develop a cross-national research base, or to promote the role of women in science and technology.

Given that the processes involved in science policy making may (and often do) differ from one type of policy issue to the next, a thorough understanding of such processes and their downstream effects requires the examination of each. The workshop series thus consisted of three separate events, focusing on each of the

three types of policy issues mentioned: the first on *Priority Themes and Topics*, the second on *Support for Transdisciplinary Research*, and the third on *Building European Research Capacity*.
The three workshops shared the following objectives:

- To scrutinize and compare science policymaking processes in different national and/or international contexts. The concern is with how policy is made for new directions in science. What instruments (structures and/or procedures) are used to facilitate the formulation and/or implementation of science policies, and how is the choice of such instruments determined? Which actors are involved, how do they gain access to the policy process, and what is the nature of their influence on it? How do policy actors interact, and what form does the coordination of such interaction take? Has the policy process changed significantly in recent years, and if so, how? By asking workshop participants to explore these and other, related questions, we seek to uncover the different realities of existing science policy processes, and more generally, to identify important trends in the governance of science.

- To contribute towards an understanding of the complex (and often uncertain) relationship between science policies and their downstream effects on scientific activities. Most inquiries into the downstream effects of science policies focus on actual policy decisions, or policy as a product. In addition to this, we draw attention to the possible impact of policy-making - or policy as a process - on the production of new science-based knowledge and its eventual socio-economic impact. In other words, having looked at differences in how science policies are formulated and implemented, we move on to consider whether such differences play a role in determining the downstream effects of the policies in question. In terms of achieving science policy goals and/or priorities, what is the impact of different policy instruments and how important are the various actor constellations, relations and forms of coordination? In brief, how does the mode of governance affect the governability of science in various national and/or international settings.

- To address “why” questions where these contribute explicitly to better understanding of the “how”. For example, each workshop include discussion of the national and regional cultural contexts for setting science policy, the extent of cultural policy diversity, and the explanatory power of distinctions between, for example, restrictive, liberal, compensatory, and constructive science policy cultures (Fuller, 1999).

- To make use of relevant theory through the preparation of a series of questions about the roles of principals in policy making, the extent of agency, the variety of actors, and the networks in which the various organizational actors are seen to operate. The comparative case studies presented at each of the workshops is analysed within this set of issues.

- To promote dialogue and exchange between science policy practitioners and scholars, and to facilitate knowledge-sharing within and between these two groups of actors.

- To make recommendations on implications for future science policy decisions and to provide practical advice to science policy-makers for improving the management of everyday science policy uncertainty. This in turn will help them to develop more effective, ambitious and viable science policy programmes.

- To contribute towards fine-tuning the broader science policy research and development agenda by identifying areas of enquiry that are relevant - in both applied and theoretical terms - to an understanding of the governance and governability of science.

Experiences from MUSCIPOLI

The Muscipoli workshop, which concentrated on “setting the agenda for science policy”, concluded that there is a need for:

- Greater awareness of the many ways priorities are set
- Priorities should be studied more closely as a consequence of relations, actions and interactions within the policymaking process
- Greater awareness of the variety of actors
- Linkages of actors should be studied more carefully
- Include in future analysis the many levels of priority setting
- More attention should be paid to the role of intermediary organisations
- Knowledge based management to reduce uncertainty

Cross-disciplinarity as an operational principle was in focus at the second Muscipoli workshop. The participants and their presentations (Report from Muscipoli Workshop Two) showed that Cross-disciplinary research takes place in many settings and in many forms illustrating a broad range of instruments used in promotion of cross-disciplinarity. The variety of instruments and measures used at different levels of the science policy system is as described in the report very big and vary from different structural configurations at the research funding level to a multitude of programs and institutions at the research performing level - and they vary from different evaluation-methods and management principles to a number of indirect as well as direct incentives for individuals and for institutions.

In the contributions different conditions were emphasised, which contribute to the success of any successful cross-disciplinary research collaboration.

Among the most important recommendations that should be remembered are:

- Cross-disciplinary initiatives should be problem- or topic-driven
- Participants in cross-disciplinary initiatives should be selected for a combination of confidence in their disciplines of origin and openness to other ways of viewing the world
- Cross-disciplinarity requires time for confidence building
- Cross-disciplinary initiatives need a supportive reward structure
- Cross-disciplinary initiatives need an influential audience

The discussions in the European Muscipoli project, not the least within the third workshop looking specifically to the building of European research capacity as well as from the first and second workshop, all based on experiences from different national as well as international sources, support the conclusion that science is under pressure and that management takes place with a high degree of uncertainty in science policy. The pressure takes many forms and come from many different sources.

Science under pressure

- Science policies are created and implemented in complex systems (MUSCIPOLI, Workshop One).
- Increasing complexity in the knowledge production.
- New issues, new problems; but have they always been a challenge for science? No, but increasingly they are presented as such.
- Increased expectations to output, research based solutions expected to all types of problems and science are perceived as instrumental.
- Internationalization has increased, and there is a pressure from internal as well as external sources.

- Science and society is in focus! “In a knowledge based society, both policymakers and citizens should be equipped to make informed choices from the growing range of options thrown up by scientific and technological progress” (EU: Science and Society Work programme and 6th Framework Programme).
- Industry and science expected to cooperate. The entrepreneurial university is on the agenda (Etzkowitz et al., 2000, MUSCIPOLI Workshop Three, 2003)
- Interplay between national and European research funding; The European Research Area (ERA) is announced by the European Commission as a goal.
- Research cooperation a must, individual researchers are “dropped”.
- Discussion about valuation of research; research must be valuated but how to valuate research?
- How to prove societal quality?
- All in all: a greater demand to science to demonstrate societal impact!

What is the management response to these challenges?

Appropriate steering instruments for ministries:

- Contracts formalized between ministries and research institutions
- Concerted actions among different kind of research funding agencies
- Demand from policy makers for cross disciplinary research
- Benchmarking exercises expanded on request
- Valuation of research, methods under development
- National Evaluations are growing in numbers
- Use of evaluations across Europe
- Performance indicators requested (often of a statistical kind)
- New forms of management
- Establishment of “Dynamic Research Groups”

External policy related issues

Some issues can be considered external to short term science policy:

- Building European Research Capacity (Human resources)
- Building European Research Area
- The Barcelona declaration, “The Barcelona destination” defined as 3% of GDP spent on R&D.
- The use of evaluations in relation to policy making
- Control versus trust (The analysis of the use of evaluations across Europe showed that in Finland evaluations are used as a development tool)
- Steering versus freedom as a norm (Results of an analysis of Danish debates, (Andersen 2003)) Not necessarily a contradiction!
- Focus on strategic instruments more than on strategic aims.

Main problems attached to changes in research environment:

- Long term perspective in funding needed, but
- Short term perspective in funding provided
- Short term perspective often used in evaluations
- Innovation more than R&D on the political agenda
- Science policy has a growing tendency to focus on innovation more than on science
- Too much emphasis on efficiency and practical implications
- Too much emphasis on control in the majority of evaluations
- Dominant use of peer reviews gives risks for problematic evaluations of new problem areas and cross disciplinary activities

- Instruments used by “Institutions” not fit for changes

Summary:

- Science is under pressure. One of these pressures is the increased expectation to science, and its expected interplay with society
- Socio-economic power is the ultimate authority (Ziman 2000)
- Many instruments are used to measure how science reacts to increased pressure
- Evaluations are as a systematic exercise one of the instruments
- Evaluations are used everywhere in Europe, (see “The Use of Evaluations in Europe” Report from the European RTD Evaluation Network Meeting, The Danish Institute for Studies of Research and Research Policy)
- Evaluations in Europe are dominated by peer reviews (op.cit.)
- Evaluations have problems with interdisciplinary research (Aagaard, 2003)
- Evaluations will continue and increase as an instrument used by policy makers
- Evaluations will be part of a ritual of control instruments
- Evaluations across Europe need comparative instruments
- Need for more coordinated evaluation methods
- Instruments for Socio-economic Evaluation of RTD policies under way (see EPUB report about evaluations of RTD Framework Programmes)

Evaluations are used for checking the quality of research across Europe, but evaluations are not the only instrument, and maybe not the most relevant instrument when it comes to responses to changes in research environment and when innovative institutions are the most wanted in present policy.

Other forms for management instruments will turn up and give other responses.

Management with uncertainty in science policy will be a behaviour we often meet in practical research management, in itself it does not provide an instrument but is a responsive way to cope with the situation.

Management with certainty about short term goals might lead to management with a focus on reaching the high score on the measurement instrument used by policymakers at a given moment in time. Resource reallocation might be an institutional response not necessarily of benefit for the overall goal for a research institution, and the question can be: “What is the future for public research institutions?” and “What is the future of European Universities?”

Can new forms of management make them survive with old norms still prevailing?

Evaluations might not be the best institutional response to changing research environments! And especially not evaluations based on peers, which runs a high risk of putting too much emphasis on the traditional disciplines. But such evaluations are often the response to challenges!

What role will research councils play in the future? How do they evaluate research under changing conditions?

Necessary to question evaluations as instrument for *not established* areas:

- What are the other instruments that can be used?
- Records of former activities, patents, publications
- Measures of societal impact collected with respect for time lag!
- Alternative: Give room for research activity that is give wide freedom

Challenges are new and increased in addition to the ongoing well known challenges, but reactions so far are old! What kind of institutional responses could be developed along the road? Benchmarking is one kind of institutional response, and benchmarking with awareness of the great questions is extremely relevant!

There will be different institutional responses in different areas of science and different responses in different cultures. Different evaluation modes that depends on scientific fields and cultures will be needed.

Recommendations

- Take a closer look at research management in dynamic research groups to find out what characterizes dynamic research environment ("Innovation and dynamics in public research environments in Denmark: a research-policy perspective" in Science and public Policy, vol. 30, no 2, April 2003, pp. 107-116), where the following conclusions can be found
- Leadership quality necessary both with respect to management but also with respect to science
- Leadership and management focus on research activities, research quality and development of competences
- Leadership and management focus on organizational efficiency and productivity
- Human resources well educated/ building capacities must increase
- Distinct research profiles: researchers in such environments are predominantly engaged in research areas that are unique (that is one area not focus on in other research environments in the country)
- Clearly formulated research strategies and research objectives
- Strategic planning
- Research strategies encompassing planning and co-ordination of activities, formulation of target areas and prioritization of research areas and research projects
- Networking
- Funding is necessary, both public and private!

The "social contract for science" is still relevant; the political community agrees to provide resources to the scientific community and to allow the scientific community to retain its decision-making mechanisms and in return expect forthcoming but unspecified technological benefits. These ideas continue to have currency, although David Guston used the term "The Fragile Contract", see Guston 2000.

But even though we can narrow down the characteristics of dynamic research institutions or research groups there is still much uncertainty in science policy.

Managing with uncertainty in science policy meaning managing with a high degree of awareness of uncertainty might be the solution!

It is not an instrument but an institutional way of coping with the situation, and it has implications for the use of evaluations.

For further guidelines in an uncertain situation see:
Guidelines for Managing with Uncertainty (2003) at www.afsk.au.dk/MUSCIPOLI.htm

Steering instruments used by Policy makers and Responses from Research Institutions to Challenges in form of Changing Research Environment

Challenges Issues on the agenda	**Policy makers** Actions/Steering instruments	**Research Institutions** Responses
New issues/problems at national level	Political initiatives to turn research into issue-oriented research programmes. Contracts	Our business?? Reactions vary From willingness to reluctance or resistance
New issues/problems at European level	Taxonomy of societal problems Problem oriented research programmes	European research networks and institutions created to study such problems
Expectations with respect to solutions/warning:	Not very specific, Often very vague, general	Not all very willing to develop instruments
Societal functions	Demand for cross disciplinary research Ask for measures	Engage in cross disciplinary research (and education) Evaluations difficult
Societal impact	Demand of socio-economic impact	Evaluations difficult
European added value	EU Framework Programmes	Impact assessments
Science and society	Search legitimization of spending on science. Establish “think tanks”	More emphasis on dissemination and public understanding
Science and industry	More and more clearly stated as goal among policy makers	Contracts Networks Patents Innovation
National research agenda adjust to the European agenda	Interaction declared as intention and supported by national programmes	Benchmarking of institutional performance Evaluations
Focus on research groups versus individuals	Programmes with support to larger research groups	Fusions of research institutions
Validation of research wanted	Policy makers ask for measures of the value attached to R&D	How to measure? Bibliometric studies! Exploration of other types of validation
Societal challenges dominate	Science policy Dream of stimulus-response Evaluations wanted	Management response Management with uncertainty

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2.2. Research management between research and politics - strategy processes in national research programmes

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Research programmes at national level make up one of the most explicit interfaces between politics and research. Scientific work and research are multi-actor activities where networks across institutional borders are a significant and often predominant characteristics of the activities' organisational format. Research management is usually not a matter of central master plans and one-sided top-down planning. Research management is moreover a dispersed phenomenon. It is not gathered in one single location or at one single decision-maker. It is a normal aspect of ordinary work of individual researchers and scientists to think strategically, co-ordinate and align actors and activities, to disseminate goals, make decisions and prioritisations, etc. Many researchers contribute actively to development of networks, organisations and practice communities. At the same time, institutions and the professional position of actors are of high importance in research management. And so are actor constellations, support from interests groups, interests, power and politics as well as interaction with the political and regulatory system not least at national level. Public policy and governance of science and research is thus also an important aspect of research management.

National research programmes are one of the places where research management at national level is carried out; where prioritisations and decisions influencing countries' research community are made. In this chapter, we consider strategy processes within national research programmes as one of the most central places for research management and governance. We investigate how, and under which conditions, strategy plans are developed, which actors are involved in the strategy developments, and which rationales, systematics and structuring means are employed in the strategy processes.[22]

By national research programmes we mean central national research funding functions and funding institutions with a specifically, whether broadly or narrowly, defined area of work. Examples of national research programmes are both strategical research programmes within specific resort areas, problem fields or sectors often connected to a specific ministry of the country, and more general research councils connected to ministries of science and research. We focus on the general and overall strategies of the research programmes rather than the strategic aspects involved in, for instance, decision on funding of a single project within the programme or in, for that sake, the establishing of the programmes. These different strategy aspects are, of course, often interrelated. The examples used are primarily from two different, but related research programmes in Denmark, namely the strategy processes of the Technical Research Council (STVF) and of the Energy Research Programme (EFP).

Background: Research programmes between research and politics

Though national research programmes in many countries account for a smaller amount of the total research funding compared to funding through universities' and research institutions' basic resources and compared to the funding from companies (in Denmark approximately 20-25% of public research is funded through research programmes (Forskningsstyrelsen 2003 p. 9-11)), national research programmes play quite an important role for the development of science and research.

[22] The study behind the text is funded by the Danish Social Science Research Council (SSF) and Risø National Laboratory.

National research programmes often channel money to new and important emerging research areas and topics. Through this, they contribute to changes and development of new directions for research institutions and for the research community in general. The strategies and micro-politics of research programmes can thus have a central role, in some cases a pivotal role, in the broader strategies and developments of science and research systems. To manage national research programmes is a highly important part of research management in general.

The dynamics that the programmes induce are at another pace and cadence than the structural institution dynamics and development patterns of universities. By being a second string of research funding in addition to the national basic funding of the research institutions, the research programmes contribute to competition within the research system. The competition is not only between institutions, but also between individual researchers, research areas and approaches. At the same time, research councils and other national research programmes can be an important arena for co-ordination and formulation of common views between researchers and institutions.

National research programmes are influenced by national policy. Not only are the programmes by their definition created through governmental decisions and prescriptions. They are often also in frequent contact and interaction with national policies of research as well as policies of other areas. This happens, for example, through reporting on the activities and developments in the areas they deal with, through communication about new state budget proposals and new important areas of research. Much of the interaction happens through the ministries and the administrative-regulatory system there.

Practice and management activities in national research programmes also reflect and are influenced by the research fields and areas of work of the programmes. With the position in central national administration, strategy processes in national research programmes thus appear under the influence of both current tendencies in general policy practices and norms and current understandings and change trends in connection with science and research. The programmes mediate between national politics and the programme areas and their institutions.

In this mediating arena between politics and research, the managers of the research programmes are in a situation where they must, in practice, secure appropriate strategy development for the programme. They shall address questions on how the subject area of the programme shall be described and understood and which means and measures are needed to develop the programme or to, at least, secure the programme's cohesion and existence. The programme managers have to consider which information and experience areas that shall be employed to develop the strategies, who shall be involved in the strategy processes, and which methods and approaches for the strategy developments that are practically feasible, appropriate as well as fair and suitable in consideration of the programme's definition and position and of the related parties. This also includes questions on how legitimacy and accountability for the programme is supported and considerations of which interests and needs that shall be satisfied, for example, in order to maintain support for the programme.

The strategy processes in national research programmes reflect the influences from the surroundings of the programmes, not only in the sense that they reflect specific topics of current interest in Government, research communities, etc. They also reflect the broader discourses and norms about the character of science and its role in society. With their central position in national research policy and research management, national research programmes are a place where discussions of the social contract for science and research, as it metaphorically has been coined (Guston 1994), take place. Also, the societal role of research and the identity and position of science in society are negotiated in the strategy developments. With the close connection to politics and the central position in general, the aspects of the current changes in the identity and societal role of science and research can in many cases appear explicit and very distinct in the interaction in and around national research programmes. For example, aspects of the societal demand for research cf. the Mode 1 – Mode 2 discussions (Gibbons et.al. 1994) are often clearly pinned out.

What is interesting about studying strategy processes of national research programmes in the perspective of the changing role and identity of science in society, is not least which typical actor roles that are inscribed in the strategies and, especially, what picture of the role and character of science that is present. The represented understandings of knowledge development processes and the understandings of technology development and technology areas are also important and central issues.

Strategies and realities are two sides of the same coin. You cannot separate them from each other and they are deeply integrated in each other. This does not mean that it is impossible, as we do here, to focus on the strategic aspects and strategy processes, but it means that you will have to consider the situation and contexts of the strategies and the subject areas it is *strategies for* when carrying out the study. Approaches that make a clear cut between strategic aspects and non-strategic aspects are of limited value. For normative suggestions and recommendations, it also means that you cannot just directly copy approaches from one area to another.

In the study behind this paper, we focus on technology-oriented research programmes (techno-scientific programmes), i.e., programmes in which technology development is one of the most central elements. With this delimitation of the project, we are lucky to be involved with a mainstream part of science and research and with one of the parts that is explicitly discussed and highlighted in the research political discussions, in the media coverage and in public discussions of science, universities, etc. Influential and dominating policy issues such as 'innovation' and 'public-private collaboration' are directly addressing technology-oriented research, as development of new technology is a very central element in these, whether being implicit or explicit. The connection between the dominating research policy themes and other research branches, e.g., social science and humanities is unclear and often hard to find. The same can to some extent be said to be the case for concepts within current studies of research management, governance, and policy such as the triple helix concept, public-private partnership, and entrepreneurship. This is, however, partly due to a lack of alternative formulations from social science, humanities, etc., about the character of research management and governance activities.

A governance perspective on science and research management

As it is the point in the recent years' governance literature, the strategies and plans of national research programmes occur not as a governmental dictate or as autonomous processes detached from governmental influence, but are developed in interaction between governmental authorities and policies and actors in the covered activity areas. This is also described in governance literature on science and research specifically (Hackmann 2001a+b, Fuller 2000, Glynn et.al. 2001, Fèron & Crowley 2002, Goncalves 2003) as in the more general governance literature that often emphasise the connection between types of governance approaches and the issue of democracy (March & Olsen 1995, Pierre 2000, Hirst 2000). The question is not if there is interaction between Government actors and actors relevant for the research areas to be managed, but which actor groups and networks are included in the processes, and which are excluded. It is a question on how, in which interaction processes and with which weight the different actors are represented and involved in the processes.

The 'new' governance approaches is governance in and by networks of actors. They focus on interaction and co-ordination between actors instead of having a hierarchical view on governance. And they emphasise the importance of decentralised activities and the interplay between centralised and decentralised steering. With this network and social co-ordination perspective, governance studies are in accordance with the knowledge in the field of social studies of science, technology and society dynamics (STS). These studies have documented that heterogeneity and a complex and thorough mutual integration of social and technical matters, of human and natural matters, are general characteristics of science and research in the present society. The construction of new research areas and new knowledge and technology occur in interactions between heterogeneous sets of actors (not homogeneous sets of actors, e.g., not only through scientists

within a well-defined area of work) and through a heterogeneous diversity of different complex dynamics. Scientific activities and knowledge are situated and influenced by the specific context. The change processes have co-shaping and network character with complex and continuous discussion, experimentation and negotiations between actors. This is why it can be said that research management is distributed. There is a mutual shaping of new institutional actors, power structures, and networks and new knowledge and technology.

In recent years, the classical social science principal-agent theory has shown fruitful in studies of governance of science and research, especially in studies on research programmes and funding functions (Braun 1993, Guston 2000, van der Meulen 1998). Of course, there are compared to the STS studies and the governance studies limitations to this approach, given the highly simplified picture of the situation, actor set-up, etc., the model with a principal and an agent offers, which does not capture the complexity and heterogeneity of research development. However, the approach throws light on the important central relation between Government and research management and the delegation of tasks and competences by the Government to research councils and research programmes prescribed in formal rules and law texts.

The principal-agent studies points to the importance of boundary organisations between Government and research and the central role these to some extent independent organisations play in the management and development of research. The way these boundary or intermediary organisations are structured and institutionalised is very influential on the development of science and research areas as part of society. The way the boundary organisations act and the communication and information flows in and around them are of critical importance. The constantly renegotiated relationship between research and Government to a considerable extent occurs in connection with the activities of these organisations.

The limitations of the principal-agent approach are clear, not least when it is questioned: Who is the principal and who is the agent? In some respects you might as well consider the situation in governance of science the other way around: that science policy and the national governance of science shall serve science and make the best possible frame for science. This is also relevant in connection with national research programmes. In practice, the research actors do not consider themselves as primarily being in an agent role for the Government. The understanding that science is a grass root activity, which shall be facilitated by the public and the national governance rather than being steered, is an understanding you often meet. Another limitation of the principal-agent model is the unequal distribution of information pre-supposed in the model. This is not as one-dimensional as the model suggests with simply more knowledge about the field at the agent than at the principal. The information differences go along many different dimensions and are to a considerable extent a question of different perspectives.

Research processes and production of new knowledge are increasingly influenced by their surroundings and by societal demands. At the same time, science and knowledge production are getting a more central and strategical role in society and are by many considered the central driver of development and economy. This is captured in the term knowledge society. The increased focus on the strategic role of science, knowledge and also knowledge intensive technology also means that there is more attention to the strategies of research programmes.

It is widely recognised among actors involved in management of research programmes, that research and research institutions to a much higher degree than earlier, also compared to just 10 years ago, are under pressure for showing the relevance and societal use of their research and need to consider these aspects in their activities. The pressure on research and on research programmes to be able to satisfy societal demand is higher than earlier. This is in accordance with the Mode 2 – Mode 1 discussion of research.

It is at the same time recognised that the pace in research activities is considerably higher than it was earlier and that the speed of change has gone up. We live in a change-oriented culture, where tomorrow and the ability to define what tomorrow will bring receives more and more attention. Change and development (rather

than continuity, stability, and tradition) are central and powerful elements in the set of values and norms within science and technology-oriented research (van Lente 1993, Brown et.al. 2000).

The emergence of the research programme instrument

The institutionalisation of national research programmes is one of the later developments of the research systems. Over the second half of the 20th century, research systems have grown and become significantly more complex. While the institutionalisation and funding of public research prior to World War II by and large consisted solely in universities and other higher educational institutions and the basic governmental funding of these institutions, the number of types of institutions and funding functions has increased considerably thereafter (Grønbæk 2001).[23]

The research councils were created in the period up until the late 1960's. In Denmark, the research council system was established in 1968, though the first council, the Technical Research Council (STVF), already appeared in 1946, however, during the first years without the same role as governmental funding institution as later. It was one of the reasons for establishing research councils, originally, in the western countries to ensure that direction, prioritisation and goal-setting of research were not only a matter of internal institutional strategies and prioritisation, but that some co-ordination across research institutions was happening and that influence from outside science on the direction and goal-setting of research was possible. Development of research should not only be a matter of internal institutional policy at the universities (Foss Hansen 1996, Aagaard 2000, Guston 2000).

Research was increasingly considered an important element in the development of the welfare society and its economic growth. The role of research and innovation for societal development were promoted, for example, by supranational organisations such as OECD. During not least the 1970's, different ministries created a number of new public research institutions working specifically in areas of relevance to the working area of the ministry ('sector research'). In addition to the direct basic funding of the universities, the funding function of the research councils and the individual ministries were now also important parts of the total research funding.

The institutional instrument of strategic research programmes occurred as an important element in the research governance and policy in many countries during the 1980's (in Denmark, primarily from the mid-1980's and onwards). Through the strategic research programmes were specific research and technology areas, problem fields and goals pointed out as research issues from national policy level (Aagaard 2000, Ståhle 1992).

The Danish Energy Research Programme is in this connection an exception to the general picture as it was established already in 1976, not least as a reaction to the oil crisis. Other research programmes such as the technology-oriented TUP (The Technological Development Programme), BIOTEK (The Biotechnological Research and Development Programme) FØTEK (The Food Technology Research and Development Programme) were established between 1985 and 1990 (Floris & Rieper 1995). The establishment of the strategic research programmes can in many cases be seen as a prioritisation of research areas related to industrial policy and development (Jensen 1996).

Some strategic programmes have been administered by the resort ministries, e.g., EFP (in the Ministry of Energy, now in the Ministry of Economic and Business Affairs) and TUP (in the Industry & Trade Agency under the Ministry of Industry) and other programmes by the research councils, e.g., BIOTEK. In many cases, a cross-institutional co-ordination or background committee was also involved.

[23] For overviews of the developments in the institutionalisation and governance of research systems, see, for example, (Hansen 1996, Aagaard 2000, Grønbæk 2001, Guston 2000, Benner 2001). The first three focus on Danish developments, Guston on USA, and Benner on Sweden.

The research councils also became more 'strategic' during that period, which can be called the strategic turn in national research management. In 1987, it was incorporated in the regulations for the Danish research councils that a part of their task was to describe strategy plans for their working area. The obligation to define strategy plans was another means of securing strategic prioritisation and co-ordination across the individual research topics and research institutions (Aagaard 2000 p. 61). With a report on the state of and perspectives for the techno-scientific research ("Teknisk-videnskabelig forskning: Status og perspektiver") published in 1983, the Technical Research Council was the first council to develop a strategy plan (Grønbæk 2001, p. 101). In the governmental regulation text prevailing from 1997 up until the present day, the obligation to make strategies is stated as follows:

"The national research councils' tasks in connection with the support of Danish research include: ... ...2) A strategy function, where the councils produce strategy plans that can lead to research council initiatives or to strategic programmes, which can be established by relevant ministries."[24]

The strategy plans produced by the research councils are five-year plans. The annual one-year plans that are used not least as input to the state budget negotiations within the Government and the Parliament are by many of the involved actors considered at least as important. They can, for example, play a role in connection with initiation of new strategic research programmes. The one-year plans are usually co-ordinated with the five-year plans.

Research policy has together with the occurrence of the knowledge society over the last decades grown in many countries. Research policy is becoming more and more explicit and pronounced. Science is now something that shall be governed like many other societal issues. The research ministry in Denmark has over a 15-year period developed from being a new and small ministry with a few tasks and relatively little influence to an important and influential ministry visible in the general national policy and on some issues with a co-ordinating and leading role for other ministries. After 5 - 10 years of debate and organisational experiments, new basic laws concerning the universities and the research advisory and funding system were in the Spring of 2003 decided upon. The adoption of these new laws can be seen as the culmination so far of the power of the research policy and the research ministry. The name of the ministry is currently the Ministry of Science, Technology and Innovation.

It has for a long time been normal to look to other countries and the way they constitute their public governance institutions when changes in the structure and institutional set-up are to be made (Foss Hansen 2000 and 1996). The Ministries of Research have in this way developed in parallel in many European countries. However, it turns out that the specific constitutions of the institutions in the different countries are, although similar at a first glance, often very much of local character and influenced by the specific political and cultural context.

Industry-orientation and Europeisation

Apart from the above-mentioned general tendencies of knowledge society, strategic turn, network governance, etc., managers of national research programmes are currently facing a number of other specific challenges and trends that will influence the practice and strategies of the research programme management over the coming years. One of them is the business and industry orientation of public research and universities. This development is not exactly new as there have also in the late 1970's and the 1980's been called for increased industry-university collaboration, not least in the technology-oriented areas. The tendency has, however, also in the latest years been enforced and strengthened in research policy and debates on the topic. The new Danish university law includes the business and industry representation in the

[24] The Danish Minister of Research, Jytte Hilden, LBK nr. 676 af 19/08/1997 Bekendtgørelse af lov om forskningsrådgivning mv., § 4b (my translation).

Boards of the universities and is but one of the recent examples of the direction of public research towards business and industry.

The business and industry orientation has been increasingly routinised over the last 25 years and is to a larger and larger extent seen as a norm for public research activities. It has to a considerable extent become a part of the identity of techno-scientific activities. The role for science in this techno-economical world order is to be suppliers to industry and through this contribute to the economical growth of society cf., e.g., the recent action plan by the Danish Government 'From thought to invoice' ('Fra tanke til faktura'). This discourse builds to a large extent on the understanding and metaphors of the 'linear model' of development going from a scientific idea over technology and innovation to diffusion and industrial production and consumption. This model is not supported by studies of science and technology dynamics or studies of the dynamics of knowledge society.

One of the other important current trends in the management of the research programmes is the Europeisation. The increasing importance of the European Union in societal development, legislation work, policies, trade and production in general is a phenomenon that might significantly influence the strategies of national programmes. There is an increase in transnational relations and networks, reflected in terms such as globalisation and internationalisation, and the role of the national state is diminishing. With the European research programmes and the thoughts about a European research area and European Research Council, the national research programmes are now in a situation where another level of research funding and research co-ordination has occurred. This is not least significant in the technology-oriented areas. The programmes and the national research governance are in general currently developing practices that can handle this and co-ordinate the national efforts with the European. The increasing dominance of English language is also a part of the general Europeisation and the cross-national harmonisation that is happening. In science and research, however, English has for a long time been one of the most used common languages.

Strategy processes in the Energy Research Programme (EFP)

The Danish Energy Research Programme is managed by the Danish Energy Authority, which is located within the Ministry of Economic and Business Affairs (earlier in the Ministry of Environment and Energy). The research programme has traditionally been considered a strategic programme and is closely connected to Danish energy policy and government. The programme strategies are co-ordinated with the general governmental plans on energy issues and, for example, also with the general national research strategy developed in the mid-1990's (Miljø- og Energiministeriet 1995 and 1996).

The strategy processes of the Danish Energy Research Programme is performed by the Energy Authority in interaction with, apart from the Ministry and Government, the energy systems operators (semi-public power production and network operators), industry and the research community. Apart from the system operators, the set of industry actors consists not least in manufacturers of energy generation technologies and of building energy equipment such as pumping systems and isolation products. A board of high-level industry and research representatives, The Advisory Council for Energy Research (Det Rådgivende Energiforskningsudvalg, REFU), is central in the strategy development and in the definition of the priority areas of the programme. Up until recently, the list of priority areas has appeared this way (with smaller changes from one year to another, IEA 1999 and Energistyrelsen 2002b):

1. Oil and gas
2. Biomass
3. Production of electricity and heat
4. Wind energy
5. Energy consumption in buildings and solar energy
6. Advanced energy technologies (fuel cells, super conductors, etc.)
7. Electricity savings and electricity efficiency
8. Energy and society
9. Industrial processes and products

Advisory committees for each of the identified priority areas are established with members from the industry and research institutions working in the area. The committees play an essential role for the programme and provide input and background papers to strategy developments (IEA 1999). There is a relatively strong network between the programme management and the established industrial actors and research actors in the energy technology field. In this sense, the strategy processes of the energy research programmes correspond to the interaction perspective in the governance literature and to the Mode 2 model of research. Demands for the research are inscribed in the strategies primarily through the energy systems' actors, the industrial actors and through governmental policy. Considerable parts of the connections to the industrial and energy system actors have lasted for long time and are relatively strong and stable. It can, therefore, at least in some respects, be said that there is a partnership between government and the established industry and research institutions in connection with the energy research programme.

The Danish Energy Research Programme has experienced some turbulence during the latest years following the change in the Government in 2001. The program was reduced from approximately 100 mill. DKK to less than half (40 mill. DKK in 2003), but is expected to be approximately 70 mill. DKK in 2004 (Miljø- og Energiministeriet 1999 and Energistyrelsen 2003b). During this turbulent period, the Advisory Council developed in their own name a recommendation for a strategy (REFU 2002). The Government has, however, not approved this suggestion of a strategy. Given the smaller total budget for the programme, it was decided that the strategy development in 2003 should be concentrated on four areas only: biomass energy, solar cells, wind energy and fuel cells. Both in these current activities and in the Advisory Council's strategy recommendation, is the technology focus stronger than in the earlier programme strategies. There is presently a call from, among other, the energy systems operators for a new general and comprehensive strategy for Danish energy research (e.g., Eltra 2003).

Strategy processes in the Technical Research Council (STVF)

As one of the six traditional research councils in Denmark, who have now existed for more than three decades, the Danish Technical Research Council develops five-year strategy plans. The 15 members of the Council are researchers, primarily from universities. The research council is located in the Danish Research Agency under the Ministry of Science, Technology and Innovation as are the other parts of the 'research advisory system'. The amount of research money managed by the Technical Research Council is in the order of 100 mill. DKK per a year plus, in some years, a limited number of special programme appropriations in the national budget targeted specifically at issues defined in the budget.

The latest strategy plan for the Technical Research Council is Strategy Plan 2003-2007 published in August 2002. The development of this research plan turned out to consist in three main phases:

1. Visions papers development
2. Definition of strategic efforts ('strategiske satsninger')
3. Elaboration of communication format

The actors involved in the interaction on the development of the plan were primarily the research council members and the employees of the Research Agency. Large parts of the interactions, including the decisions on how to advance in the process, consisted in internal discussions within the council. The Chairman and a working group, also including a couple of other members, were the council members who carried out much of the work.

However, a number of Danish techno-scientific researchers outside the Council were asked in the first phase to write papers about their visions on developments in their research areas as input to the strategy process. The vision papers should all cover all the different areas within techno-scientific research. The authors, who not only came primarily from public research institutions, but also from private enterprises, were handpicked by the Council as experienced, visionary persons, also able to describe broader, cross-disciplinary thoughts about development of the research. Approximately 45 vision papers were submitted.

The council members described and discussed during the second half of 2001, the different areas of techno-scientific research, building on, among other things, the vision papers. On the basis of this, 7 strategic areas were defined for the strategy plan. The strategic areas can to some extent be seen as a representation of main areas of techno-scientific research, so that the complete field is covered all in all, integrated with specific current topics and relevant perspectives.

The strategy processes that are considered by many of the actors most important during that period are, however, a parallel discussion about a new measure to be employed in the Council's funding function. Through these discussions, 'research consortia' are defined as a type of funding in addition to the existing instruments such as engineering research centres, framework programmes, and talent projects. The research consortia instrument is a reaction to the demand for improved collaboration of public and private research. In the definition of a research consortium, openness and public access to the result of the research collaboration are emphasised and a number of companies (not only one) must be involved. The resort consortia instrument is included in the list of strategy areas for the strategy plan. The 8 areas are:

1. Biotechnology and Chemistry.
2. Energy.
3. Environment.
4. Nanotechnology.
5. Production and materials-technology.
6. Information systems.
7. Simulation.
8. Research consortia.

The third phase of the development of the Strategy Plan 2003-2007 gets a more important role for the final result of the strategy work than is possibly suggested by the term communication format. Though it from the beginning of the process was clear for many of the persons involved from the Council and the research agency that the Strategy Plan would be simpler than the previous five-year plan (1998 – 2002), a final decision on making the Strategy Plan in a quite brief and politician targeted format was first made in the first months of 2002. The decision has created discussion in the research council and, later, among researchers in the broader Danish techno-scientific community.

The research agency played, in collaboration with the council, an important role in the definition of this communication format. The agency elaborated a template for a handy, clear and appetising colour layout, which they encouraged all the research councils to follow (only the Medical Research Council resisted the brief format). The Strategy Plan ended up being a publication of 28 pages with many pictures, brief texts, and boxes with short examples of the use of techno-scientific research and statement quotes from well-known and high-level industry representatives. This shall be compared with the approximately 100 full text pages of

the Strategy Plan 1998 - 2002[25]. A lay-outer and a PR company were hired to go into the work with the finalisation of the publication.

Compared to the earlier five-year plans, Strategy Plan 2003–2007 is aimed primarily at politicians, trying to convince them to contribute more money to the techno-scientific area. While the earlier plan focused on the 'internal' prioritisation and strategic action in the research council and on the different sub-areas within the main areas of techno-scientific research, the plan for 2003-2007 emphasises the societal importance of techno-scientific research; that techno-scientific research makes a difference for society.

The development of earlier strategy plans as well as strategy plans of other research councils, e.g., the Natural Science Research Councils, have employed broader hearings in the strategy development process. A mediating and co-ordinating role for the 2003 – 2007 plan within the research community as well as internally in the research council is not expected. In practice, there are indications that the Strategy Plan has at least to some extent, however, some co-ordination and direction-giving effect on the research community. More concrete initiatives, or action plans, from the research council following the strategy plan are not expected for the time being. Apart from the actors mentioned above - the research council members, the agency employees, the PR company and the vision paper authors - only a few other persons have been directly involved in the development of the Strategy Plan 2003-2007.

The strategic work of the management of the national research programmes is not always devoted to pointing out priority research areas and describing plans for exploration of them, but can have many other purposes and functions. Only some of them have been mentioned above. Below is a tentative list of the functions identified in the Danish Energy Research Programme and the Technical Research Council.

Tentative list of strategy functions:

The strategy of covering all existing research areas
- supporting existing areas

The strategy of more money
- getting attention to techno-scientific research; by showing its societal importance

The strategy of no strategy
The strategy of strength areas
The strategy of co-ordination
The strategy of gaps and weak points
The strategy of techno-scientific territory
- demarcation, for example, against natural science and the natural science research council

The strategy of new technologies
The strategy of developing new production and consumption systems
The strategy of serving industry

Perspectives – new laws and new co-ordinations

The management of Danish national research programmes faces in 2004 new challenges and the conditions for strategy processes in the programmes are changed on important points. Following the new law about the research advisory and funding system, the system now consists of the Research Policy Advisory Council, the Strategic Research Council and the so-called Free Research Council.[26] Within the latter, a number of 'professional research councils' ('faglige forskningsråd') shall defined, c.f., e.g., the Technical Research Council up until the present day. In the new law, there is no obligation for the Professional Research

[25] The number of pages refers to the internet published version of the plan.

[26] Ministry of Science, Technology and Innovation 2003: Lov om forskningsrådgivning m.v., L142, approved by Parliament 22 May, 2003. The law also defines a 'co-ordination board' to co-ordinate between the councils a.o.

Councils to formulate strategy plans. Whether or not an explicit strategy plan, research programme management contains strategic aspects and de-facto strategies will exist. The strategic processes will not least consist in the definition of the funding practice and the instruments. The definition of the Councils' business procedures will also be of strategic importance.

The new law emphasises open competition for national research money granted through programmes, etc., and that scientific-based ('forskningsfaglig') quality assessment shall be carried out before decisions of funding are made. The Strategic Research Council shall deal with thematically delimited and politically prioritised research areas. It shall approve the funding procedures of other ministries' research programmes such as the Energy Research Programme, and it shall do scientific ('forskningsfaglige') assessments of the applications within these programmes. It is obvious that a lot of co-ordination is needed to make this process work. The Strategic Research Council shall look for new research tendencies and can in interaction with the Parliament start new initiatives. However, it is, despite the name, not the Strategic Research Council, but the Research Policy Advisory Council that shall explicitly deal with strategic aspects of the national research governance, initiation of larger new research initiatives, as well as development of the general national research strategy.

A trial balloon for the new conditions of management of national research programmes has been the strategic co-ordination of the management in the energy research area that has taken place in the last year. The applications for the Energy Research Programme are now also, following the intentions of the new law, evaluated in the Technical Research Council and not only in the programme management in the Danish Energy Authority. However, the co-ordination goes further than that and has other reasons than the new law, for example, the mentioned turbulence in the governmental support of energy research. It is a strategical attempt to make the different research funding sources in the energy area work together. Energy research funding, apart from the Energy Research Programme and the energy research funding from the Technological Research Council, also comes from, for example, the governmental renewable energy programme and the so-called 'PSO' money managed by the energy systems operators. A co-ordination group with representatives of the different energy research programmes, etc., carries out the strategic management and co-ordination in the energy area.

That it is the Technical Research Council that in practice carries out the scientific quality assessment of the applications in the Energy Research Programmes can be seen as yet another contribution in the direction of defining the energy research programme as primarily a technology research programme. Observers in the system expect that the new regulation will result in a number of new national research programmes defined in connection with the parliamentary state budget negotiations. It is still an open question whether the so-called arm's length principle will be realised effectively. Whether the attempt to constitute an organisational border between strategic and non-strategic research, i.e., between on the one hand thematically delimited and politically prioritised areas and on the other hand a researcher-initiated research, is practically feasible and not too bureaucratic, is also an open question.

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2.3. Science policy as a frame for cross disciplinary research

Research management: an issue in the design and delivery of inter- and pluri-disciplinary research

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Abstract

Research crossing disciplinary boundaries has increasingly in the last decades been perceived as a key operational principle in the design and delivery of science policy in most western countries. It is described as an operating principle that can help accomplish a range of objectives by addressing broad issues and answering complex questions beyond the scope of any one discipline. Crossing of disciplinary borders is regarded as a necessary approach to solve societal problems and to increase wealth-creation, as it is expected to generate more innovative and more excellent research.

A main aim of the project “Managing with Uncertainty in Science Policy”, financed as a EU STRATA project under the title MUSCIPOLI was to discuss the uncertainties related to the design and delivery of key operational principles in science policy - *cross-disciplinarity* being one of the principles studied

Contributions from European partners within the Muscipoli project – much presented as case studies within the second Muscipoli workshop (Aagaard and Siune (ed.) 2002) - has illustrated that there are a number of potential barriers and problems in relation to cross-disciplinarity. These barriers can be found at all levels, said in another way from the structural and the institutional level to the individual level, and at all levels the management element is extremely relevant.

Summary of conclusions

The contributors to the analysis presented here represent a number of European countries. As a mix of academics, administrators, policy developers and agenda shapers they also represented a broad variety of institutional positions in the European science policy system.

In a number of national and cross-national analyses it has been emphasised, that cross-disciplinary institutions, programs or projects often experience conflicts with the traditional disciplinary science system. The lack of consistency between the cross-disciplinary initiatives and the disciplinary organisation in the traditional research system are mentioned as major factors explaining these difficulties. Successful cross-disciplinarity is difficult to achieve in practice because science policy decisions are implemented in organisational and cognitive locations, where they interact with existing structures, interests and ideas that for most parts are built on disciplinary premises (Siune in Aagaard and Siune (ed.) 2002).

Cross-disciplinary research takes place in many settings and in many forms across Europe. A variety of different instruments and measures are used at different levels of the science policy system. They vary from different structural configurations at the research funding level to a multitude of programs and institutions at the research performing level - and they vary from different evaluation-methods and management principles to a number of indirect as well as direct incentives for individuals and for institutions.

A barrier is found at the individual level, where incentives in the form of career opportunities are limited. Cross-disciplinary scholars are likely to experience at least some frustration at the lack of formal recognition in titles, prizes, and resources that disciplines and their institutions bestow upon their own. Institutions and programs risk becoming marginalized if they do not respect sufficiently the fact, that scholars generally make their careers within disciplines.

Such barriers and problems are related to the overall relationship between cross-disciplinary initiatives and the traditional disciplinary science system. There is a duality in this relationship, where, on the one hand, the disciplinary structures limit the possibilities of cross-disciplinary initiatives, but where the same disciplinary structures, on the other hand, are the most important prerequisite of successful cross-disciplinarity. In a number of input to this analysis it was emphasised, that successful cross-disciplinarity is highly dependent on the existence of strong, but permeable disciplines. It is also argued, that cross-discplinary initiatives only make sense if they are seen in the context of a large and diversified system of research and higher education. They presuppose that there are programs, projects, specialized research institutions and Universities with disciplinary structures. Similarly at the individual level it is necessary, that researchers and research managers cherish their disciplines identities, because it is only when they are confident of their core identities that practitioners feel safe enough to allow their borders to become permeable, without abandoning them altogether

The Muscipoli project sums up a number of recommendations regarding the design and delivery of inter and pluri-disciplinary research. Different conditions contribute to the success of any successful cross-disciplinary research collaboration and research management is just one of them.

Among the most important recommendations that should be mentioned here are:
- Cross-disciplinary initiatives should be problem- or topic-driven
- Participants in cross-disciplinary initiatives should be selected for a combination of confidence in their disciplines of origin and openness to other ways of viewing the world
- Cross-disciplinarity requires time for confidence building
- Cross-disciplinary initiatives need a supportive reward structure
- Cross-disciplinary research needs special management skills without which cross- and interdisciplinary research cann't reach success.

The design and delivery of inter- and pluri-disciplinary research

The questions of which operating principles should be emphasized and how scientific activities should be performed are central in the management of modern science policy. Key questions for policymakers, administrators and researchers are not only thematic (what areas, themes and fields should be prioritised?), but just as well operational (how should scientific activities be performed?).

One of the most important operating principles of contemporary science policy is the aim to facilitate crossing of national, sectorial, institutional and disciplinary borders in research. This operating principle has been regarded a key instrument in science policy at least in the last couple of decades and has created increased pressure upon traditional divisions of knowledge.

It has been argued, that it is a principle of growing importance as "*the proportion of research that is interdisciplinary is increasing; collaboration – domestic and international – is rising steadily, and more institutions are producing research articles. Research products combine an even broader range of skills and resources indicated by increasing interdisciplinarity and collaboration between different individuals, institutions and countries*". (Hicks & Katz, 1996; 402)

Similarly it has been argued that "*knowing how to fund, manage, facilitate and conduct collaborative research will become core scientific and policy competencies in the next century*" (Hicks & Katz, 1996).

In the second Muscipoli workshop the focus was limited to only one of the objectives in the general aim of facilitating border-crossing research, namely the crossing of *disciplinary* borders. Consequently, *the design and delivery of inter- and pluri-disciplinary research* was chosen as the subject of investigation. By investigating this theme as an example of the question of how scientific activities are performed and how operating principles are emphasized, it was attempted to address a number of more generic issues related to the overall "Managing with uncertainty in science policy" project.

Crossing of disciplinary borders in research

Crossing of disciplinary borders in research is by no means a novel phenomenon. Some claim that inter-disciplinarity has its roots in the works of Plato, Aristotle, Kant, Hegel and other historical figures, who have been described as inter-disciplinary thinkers. Others claim that it is entirely a phenomenon of the twentieth century rooted in educational reform, applied research and movement across disciplinary borders. Some have even dated inter-disciplinarity's origins in modern times as precise as 1951, where the first publication with the term *inter-disciplinarity* in its title was published (Chubin et.al, 1986).

Even though the underlying basis of the concept can be found in ideas of a unified science and the integration of knowledge, this article will limit its focus to modern science policy and the period following the 1960's and 1970's when crossing of disciplinary borders as an operating principle became an important objective in academic as well as in research policy circles.

Crossing of disciplinary borders in research is a concept of wide appeal. However, it is also one of wide confusion and uncertainty, and even though this operational principle has been an important aim for policymakers, administrators and practitioners at the very least for 30 or 40 years, a number of central questions and problems remain unsolved. There are a limited number of studies on research that crosses disciplinary borders, and as a consequence a lot of key questions of how to organise, manage and evaluate this type of research need to be answered.

There are several reasons for this widespread uncertainty. The most obvious reason is, that there is a general uncertainty about the meaning of central terms. Lack of agreement on terminology has been a recurring issue in the discourse on crossing of disciplinary borders. As Klein (1990,55) argues crossing of disciplinary borders in research is usually defined in one of four ways:

1. *by example*, to designate what form it assumes;
2. *by motivation*, to explain why it takes place;
3. *by principles of interaction*, to demonstrate the process of how disciplines interact;
4. *by terminological hierarchy*, to distinguish levels of integration using specific labels.

Before the Muscipoli workshop no authoritative terminological definition was chosen. How to use the different terms in praxis was left to the participants, but they were asked to make their use of the terms explicit in their contributions - and in most cases they did so.

The term *cross-disciplinarity* has been used as a generic adjective for all research-activities involving interaction across disciplines. It is used when referring to research that spans disciplines, but without specifying the level of integration (thus comprising the whole range of cooperation from multi- or pluri-disciplinarity to inter- or trans-disciplinarity). Just as other central terms in this area cross-disciplinarity is a problematic term, because it has been used in many different ways. In the workshop report there is a spcific chapter, where the issue of terminological confusion has been addressed (Aagaard and Siune (ed.) 2002).

Another even more important reason for the widespread uncertainty concerned with research crossing disciplinary borders is, that it very often is a marginal activity in comparison to the traditional disciplinary mode of knowledge production. It is performed across a variety of fields and areas, in a variety of public and private institutions and in a multitude of more or less formalised settings. This means that the majority of people engaged in cross-disciplinary research lack a common identity, and as a result they find themselves in a state of social and intellectual marginality. This marginality and the lack of common identity lead to a generally diminished capacity for reflection on the nature of cross-disciplinary research. Similarly, discussion of research crossing disciplinary borders literally sprawls across general, professional, academic, governmental and industrial literatures. According to Klein (1990,122) this literature tends to be atheoretical and usually lacks cross-citation to the larger body of interdisciplinary scholarship.

Obviously there is organisational and intellectual phenomena unique to single fields, but there is also a number of common problems and ideas (Klein,1990,14). The cost of ignoring these commonalities are enormous, and it is an important task to identify and discuss these questions of general relevance for a broader audience, whether it is policy-makers, administrators or researchers.

In the Muscipoli workshop there were several case studies and broader experiences to build the project on, since the informers did not only base their information on their own experiences, they also draw on their wide and for many international experience. Below only selected aspect of the input to the analysis are specified with reference to the source:

Edward Page based his reflections on his management experiences as Director of the cross-disciplinary “Future Governance Program” funded by ESRC. He reflected on the incentives and disincentives in relation to the management of such a program. He argued, that risk and uncertainty are a central part of the management-responsibilities, but ended up concluding that the advantages far outweigh any difficulties (Page in Aagaard and Siune (ed.) 2002).

Steven Rayner, Director of the ESRC Science in Society Programe went beyond the description of his own program and reflected on the relationship between disciplinarity and inter-disciplinarity. He argued, that inter-disciplinary research depends on the existence of strong, but permeable disciplines and that inter-disciplinarity is itself a specialized skill that thrives in specialized niches on the periphery of disciplines (Rayner in Aagaard and Siune (ed.) 2002). Rayner emphasises the need for special management skills.

Michael Scheuermann, Scientific Coordinator of the Global Environmental change program, argued that management of large-scale cross-disciplinary programs is a specific task and not the task of the researchers. Consequently he emphasised, that program managers need specific training in science/research management (Scheuermann in Aagaard and Siune (ed.) 2002).

The workshop focussed on specific institutions entirely or partly specialising in research crossing disciplinary borders. Experiences from German and French institutions are numerous, and the lack of more nation specific experiences in some ways limit the possibility for generalisations. But the cases studied show a remarkable variety of institutional designs, and the German cases in particular illustrate the variety that can be found even within one country. The national culture as such does not determine the type of institutional arrangement. International models and national policy initiatives interplay.

Hinnerk Bruhns described as a case the Maison des Sciences de l’Homme in Paris and illustrated how Maison des Sciences de l`Homme offers an area for interdisciplinary as well as for inter-institutional and international encounters to exterior researchers, to its temporary guests, and to the French researchers hosted for long time periods. Bruhns explained the management principles of how the MSH intervenes in three ways for inter-disciplinarity: Amongst the projects that are submitted within its walls and outside, it favours those that carry an interdisciplinary dimension; It actively provokes meetings and collaborations between researchers from different disciplines and it puts support and instruments that can go from the

temporary allocation of a work-area to the creation (and temporary support) of a scientific review, at the disposal of researchers that carry forward an inter- or pluri-disciplinary project.

Denis Bouget, Director of The Maison des Sciences de l'Homme in Nantes, presented another but rather different MSH-institution. Apart from describing his own institution, he pointed to the potential conflict between cross-disciplinary programs and traditional disciplinary institutions. He suggested, that in the future it could be expected that the process of development of interdisciplinary research will bring about an inversion of the traditional multilevel organisation, with the interdisciplinary research becoming the primary tier of research and the disciplinary research becoming the network of researchers and the second tier of the organisation.

Johannes Roggenhofer Executive Secretary of ZiF (*Zentrum für interdisziplinäre Forschung*/Center for Interdisciplinary Research, Bielefeld University) described a German institute for advanced study, which is open to the whole range of interdisciplinary basic research. Its operating principles and internal structure were outlined and several examples of recent projects were considered, illustrating not only its mission and the character of its work but showing also successes and advantages as well as specific problems of the ZiF-approach to basic interdisciplinary research. Furthermore future perspectives were shortly outlined, and an attempt to offer some recommendations for a more pertinent science policy was made in the concluding section.

Joachim Nettelbeck, Secretary of The Institute for Advanced Studies in Berlin (Wissenschaftskolleg Berlin), argued that such institutes are necessary elements of a system of research and higher education. He explained how, besides providing time and concentration for an intensive research phase, Institutes for Advanced Study fulfil a compensatory function in addressing especially the aim of planning for the unforeseen. According to Nettelbeck this aim only makes sense, if it is seen in the context of a large and diversified system of research and higher education. He argued, that in this sense they presuppose that there are programs, projects, specialized research institutions and Universities with disciplinary structures. Management aware of interdisciplinary research at all these levels are necessary.

Georg Thurn, Head of research Policy and Coordination of Wissenschaftszentrum Berlin für Sozialforschung (WZB), presented a discussion of the policy contexts and research structures, which surround WZB. Problem-orientation and the institutionalisation of pluri-disciplinary research are necessary preconditions in the management.

Out of the sum of case studies and the European discussions a number of important issues have materialised. Among the issues are: Objectives, barriers, the relationship between disciplinarity and cross-disciplinarity, and instruments and they all deserve special attention from a management perspective and each of these are analysed in the following. All references are to the workshop report (Aagaard and Siune (ed.) 2002), while much is taken from the project discussions in May 2002, but they are not accessible in printed form.

Objectives

An important question is, of course, why increased crossing of disciplinary borders is perceived as a key operational principle in contemporary science policy. What are the objectives for this operational principle, and in what way is an increased cross-disciplinary research activity expected to complement the traditional disciplinary mode of knowledge-production?

These objectives were stated explicitly in a number of the contributions from European partners. Cross-disciplinarity is described as an instrument that can help accomplish a range of objectives by addressing broad issues and answering complex questions that are beyond the scope of any one discipline.

Consequently crossing of disciplinary borders is regarded as a promising instrument in science policy, as it is expected to generate more innovative and more excellent research. It is also regarded as a necessary approach to solve societal problems and to increase wealth-creation. Bouget describes cross-disciplinary research as a marriage between conceptual frameworks and methodologies, reflecting the need to bridge, not only the different scientific representations of the real world, or the sharing of understanding among researchers, but sometimes also the compiling of common dictionaries of terms and concepts or the definition of new common objects of research, etc. All these scientific ambitions are supposed to avoid the drawbacks to disciplinary research such as the narrow compartmentalisation of knowledge, a specialised communication of scientific knowledge, 'black holes' in scientific knowledge, the risk of a tunnel-like vision, unintelligible jargon, etc. It was furthermore argued, that cross-disciplinary research can lead to creativity for new scientific knowledge in that the very act of creation often brings previously unrelated ideas together.

By Valdalbero & Osorio it was similarly argued, that the new challenges facing European research require a stronger co-ordination among stakeholders and an inter- and pluri-disciplinary effort in order to foster a competitive and sustainable development. They also argued, that it is believed to be now, more than ever before, one of the basic driving forces behind economic and social progress as well as a key factor in business competitiveness, employment and quality of life (Aagaard and Siune (ed.) 2002).

Much along the same lines Aagaard argued, that the aim to facilitate crossing of borders in research increasingly is viewed as a fundamentally important instrument in the design of modern research policy in most western countries, (Aagaard and Siune (ed.) 2002). Barriers between disciplines, institutions and sectors are seen as major obstacles to a well-functioning research-system. Underlying the demands for increased crossing of disciplinary, institutional, sectorial and national borders is often an a-priori assumption that a political facilitation of such bordercrossing will provide conditions that are good for societies outcome of research - with cross-disciplinarity perceived as one of the essential means for research to be socially accountable and help solve the complex problems of modern society. It was furthermore argued, that the problem-driven orientation of modern research policy creates a need for an increasing focus on bringing insights from different disciplines together, as many societal problems are seen as generally falling between or spanning several disciplines. Therefore there is a demand for a more holistic approach than the more partial one that single disciplines may be able to provide.

As Aagaard also pointed out, these arguments have been heavily promoted not only nationally but also internationally through organisations such as OECD and EU. As an example, the EU's Research Commisioner Philippe Busquin has recently argued, that he is "*convinced that the greatest innovations will be derived from new interdisciplinary approaches*" (Research Europe, 2000).

Barriers

Many more arguments in favour of cross-disciplinarity can be found throughout the M2-report, but the flip-side of the questions of the objectives and the potential advantages of this important operational principle in science policy is, of course, the questions of the potential problems and barriers to a successful implementation of cross-disciplinarity. As Caswill argued, this operational principle is widely applauded, and yet extraordinarily difficult to achieve (Aagaard and Siune (ed.) 2002). So when discussing the objectives of cross-disciplinary research, it is important to remember that the potential benefits in many cases have proved extremely difficult to achieve in practice, and that many barriers and problems are standing in the way of success.

Aagaard argued, that crossing of disciplinary borders often is portrayed as good per se, and that this particularly is true for the concept of inter-disciplinarity. But in the political praise of these operational principles it is often forgotten, or not mentioned, that crossing of disciplinary borders also can create a number of problems in the performance of research. He argued, that it appears to be generally accepted,

that cross-disciplinary research holds a potential for increased creativity and that this operational principle can result in an increased problem-solving ability (M2). But on the other hand, it also holds a potential of communication and collaboration problems, and this part is often forgotten. In a recent Danish Ph.D. thesis on this issue, it is argued, that we don't know very much about in which situation which potential takes the upper hand in the cooperation (Ernø-Kjølhede, 2001). Furthermore he argued, it is often not only disciplinary borders that are crossed, but also institutional or even national boundaries, which ads even more potential difficulties to the research-collaboration. For decision-makers and administrators it is important to remember that advantages and disadvantages between different modes of research have to be weighed against each other.

But the potential barriers to successful cross-disciplinarity are not only operational, but just as well structural and institutional. Caswill argued, that when individual scientists are interested in a particular research approach, funds may be available and policy encouragement provided, but there are however often high cognitive barriers and opposing institutional pressures. Caswill also argued, that science policies such those supporting interdisciplinarity within the social sciences do not operate in a vacuum. Science policy decisions are implemented in organisational and cognitive locations, where they interact with existing structures, interests and ideas. Policies in support of activities and processes like interdisciplinary research are part of larger processes of influence and agency. Caswill concluded, that the apparently simple question of why a desirable objective like interdisciplinarity often is not achieved, can be unpacked into discussion of tensions about the nature of social science and scientific knowledge, about the structural place and importance of disciplines in academic institutions, and about the ability of Research Councils as institutions to influence the nature and direction to research. Caswill also emphasised that disciplinary differences remain very much in evidence within ESRC underneath the multi-disciplinary structures. The representative academic institutions with whom the Council needs to work are almost all discipline based. The large number of applications which reference more than one discipline may be more the result of perceptions of ESRC requirements than of research plans which genuinely cross the discipline boundaries. The interventions in these systems of a funding agency like ESRC may therefore be less significant then they appear from a distance

Similarly Niessen argued, that even though the institutional set-up in DFG seems fit to support cross-disciplinarity, it is still regarded as a "problem" from all perspectives. He concluded, that it still is an important objective to identify and implement measures geared at soliciting interdisciplinary cooperation in larger programmes and centres, which goes beyond the superficial level of just gathering different disciplines under a common umbrella. He suggested, that size in itself could be a barrier, and that successful cross-disciplinarity was more likely to be realised in smaller units, even though the institutional impetus for cross-disciplinarity is larger in the large-scale programs (Aagaard and Siune (ed.) 2002).

Rayner contributed to the discussion of barriers, when he argued, that established institutions are ambivalent about marginality. On the one hand marginal scholars can provide important critical perspectives that cannot be obtained from within. They can also make novel connections across knowledge borders. On the other hand, he argued, marginals also threaten the very boundaries that constitute the established order. He argued, that perhaps this partly explains why so many universities, especially in the United States, loudly proclaim their interdisciplinary commitments, while conducting disciplinary "business as usual" within their academic departments, and declining tenured positions to those who stray too deeply into the academic no-man's land of long-term interdisciplinary work which cannot be judged by unambiguous departmental criteria.

Another barrier was pointed out by Bouget, who argued, that different types of conflicts emerge, when cross-disciplinary programs are imposed on the traditional disciplinary research system. Often the lack of consistency between the cross-disciplinary programs and the disciplinary organisation in the traditional research institutions creates problems in forms of destabilisation, difficulties in power-sharing and problems of location. Bouget argued, that this inadequacy between the programmes and the organisation could jeopardize the visibility of the programmes, and cause conflicts among researchers involved in the

programme as well as between the researchers who are involved and those researchers, who are not involved in the programmes.

Aspects of the same conflict was precisely phrased by Thurn (in Aagaard and Siune (ed.) 2002), when he argued that problem-oriented research by definition goes beyond the scientific access offered by a single discipline. The structure of teaching and research at the universities, however, often makes it difficult to work on themes that transcend the boundaries of an individual department or chair. It can therefore be seen as particular challenge for institutes outside of the universities to develop innovative institutional arrangements in order to bring together perspectives and persons for inter- or pluri-disciplinary approaches.

A final barrier of cross-disciplinarity, that was mentioned in a number of contributions, was the lack of direct incentives for researchers at the individual level. Rayner pointed out, that incentives in the form of career opportunities are limited: cross-disciplinary scholars are likely to experience at least some frustration at the lack of formal recognition in titles, prizes, and resources that disciplines and their institutions bestow upon their own. He argued, that the excitement of interdisciplinary work often is its own reward – which is just as well since its practitioners are often punished for their impertinence, not overtly, but simply by being denied the more conventional rewards of disciplinary scholarship.

Similarly Nettelbeck argued, that under the normal career patterns of most of the disciplines a stay at such a fanciful place as an Institute for Advanced Studies is considered to be a waste of time for an excellent Post-doc, even if the conceptual enrichment might be very important with respect to innovation. He raised the question of what Institutes for Advanced Study could do for postdocs, so that their career risk is diminished? Nettelbeck emphasised, that institutions and programs easily could become marginalized if they did not respect sufficiently the fact that scholars make their careers within disciplines.

Thurn emphasised this argument as well, pointing to the potential structural tensions and potentially conflicting interests that WZB had experienced in relation to the major players in the traditional system of academic research and teaching: In terms of programs and personnel, the WZB, operating outside of the university, developed an enormous degree of extremely flexible and fluid structures, but it lacked the longer-term prospects and stable agendas necessary to offer career perspectives to its fellows who found it increasingly difficult to bridge the gap between the functionally different research environments: moving from training in a discipline over to “interdisciplinary” work and back again to a “disciplinary” academic position as university professor. As a consequence of practical experience with this type of “interdisciplinarity”, it became a matter of increasing urgency to find institutional structures that would narrow the gaps and ease the tensions between this “new” type of research and the “old” environment.

These barriers mean, that cross-disciplinary programs and institutions often are struggling for legitimacy in the academy, and the “reformists”, who support cross-disciplinary movements, are often outnumbered by the “traditionalists”, who have doubts about cross-disciplinary initiatives. As the contributions showed there are many reasons for this widespread scepticism.

The relationship between disciplinarity and cross-disciplinarity

The discussion of the objectives and the potential barriers of cross-disciplinarity as a key operational principle is leading directly to the question of the relationship between the traditional disciplinary research-system and the initiatives in favour of cross-disciplinary research.

In a number of European contributions we find a strong reaction towards the popular idea of a steady advance towards a “Mode 2” future without disciplines (Gibbons et al, 1994). Rayner argued, that a paradox is inherent in the idea that scholarly endeavour is or should be moving inexorably in the direction of universal inter-disciplinarity. According to Rayner inter-disciplinary research depends on the existence of strong, but

permeable disciplines, and he argued that inter-disciplinarity is itself a specialized skill that thrives in specialized niches on the periphery of disciplines. He emphasised how researchers should cherish their disciplines identities, because it is only when they are confident of their core identities that practitioners feel safe enough to allow their borders to become permeable, without abandoning them altogether, and he argued that this is the key to successful interdisciplinary work. To strengthen interdisciplinary capabilities for appropriate applications, funding agencies and scholarly institutions need to nurture these niches, rather than establish interdisciplinary standards for everyone. According to Rayner this is where the paradox lies for those who see the future of scholarship in the mainstreaming of interdisciplinary work, the ultimate triumph of Mode 2, or the creation of a universal transdisciplinary discourse. By definition, a universally interdisciplinary landscape would be an intellectual monoculture. Without thriving disciplines, the very idea of interdisciplinary discourse becomes moot.

Nettelbeck made a similar argumentation, but in his contribution the focus was moved from the individual level to the institutional level. He argued, that cross-disciplinary institutions as the Institutes for Advanced Study besides providing time and concentration for an intensive research phase fulfil a compensatory function in addressing especially the aim of planning for the unforeseen. He argued, that this aim only makes sense, if it is seen in the context of a large and diversified system of research and higher education. In this sense, he argued, they presuppose that there are programs, projects, specialized research institutions and Universities with disciplinary structures. Again the conclusion was, that cross-disciplinarity is meaningless without disciplinarity.

Thurn delivered an interesting example of an attempt to find an institutional structure with a balance between the disciplinary and the cross-disciplinary aspects of research (Thurn in Aagaard and Siune (ed.) 2002, pp. 98-104). The solution for WZB was a new institutional set-up, still in operation today. This set-up provides a more complex structure with, on the one hand, a greater number and variety of smaller research units (of four to six researchers plus visiting fellows, doctoral students and researchers on third-party-grants etc., working under a director who, by joint appointment, is a full professor – with a reduced teaching load – at one of the Berlin universities); these units incorporate theoretical-conceptual perspectives growing out of the different social science disciplines. The smaller units are, on the other hand, brought to bear on a larger research area, the different dimensions of which can thus be studied from different theoretical points of view and with the expectation of additional synergetic effects. Through the interlocking of smaller units, representing (disciplinary) perspectives, with a more encompassing framework, representing the (interdisciplinary) dimensions of a problem area, this set-up is meant to bridge the “systemic gap” with the academic environment by facilitating the transitions to and from the universities, while at the same time retaining problem-orientation and pluri-disciplinary perspectives.

Another question related to the relationship between disciplinarity and cross-disciplinarity is, whether the current balance between disciplinarity and cross-disciplinarity has found stable level, or the balance is moving from one operational principle in the direction of another. Bouget suggested, that in the future we can imagine, that the process of development of interdisciplinary research will bring about an inversion of the multilevel organisation, with the interdisciplinary research becoming the primary tier of research and the disciplinary research becoming the network of researchers and the second tier of the organisation. Similarly Nicolescu argued, that a move towards trans-disciplinarity is essential (Nicolescu in Aagaard and Siune (ed.) 2002, pp. 108-112). This statement was challenged in a number of contributions, but the question and the uncertainty remain. How do we find the optimal balance between these two key operational principles? This balance need to be found at both the international level and at the national level, as the potential conflicts applies to all types of cross-disciplinary initiatives from institutions and large-scale programs to minor projects.

Instruments

The contributions showed that cross-disciplinary research takes place in many settings and in many forms. A variety of different instruments used to promote this operational principle were illustrated throughout the report from the Muscipoli workshop. The instruments and measures used at different levels of the science policy system vary from different structural configurations at the research funding level to a multitude of programs and institutions at the research performing level, and from different evaluation-methods to management principles and incentives for individuals as well as for institutions.

The case studies showed that the *research council structures* are perceived as an important instrument to induce and facilitate increased cross-disciplinarity. It is attempted to reduce inter-committee or inter-agency boundaries, to eliminate bases for implicit budgetary egotisms in the decision-making process on centres and programmes – and to promote networking across disciplines by explicitly asking for it in the philosophy of the funding schemes. However both Caswill and Niessen emphasized, that the structures alone in favour of cross-disciplinarity are far from sufficient to secure a successful implementation of this operational principal, since the traditional disciplinary structures of the surrounding science policy system limits the influence of cross-disciplinary initiatives taken at the research council level. With Caswill's words an important lesson is, that an internal analysis of science policy organisations alone, whether of structure, or policies or actors, will not provide sufficient explanation for the difficulties. That can only be attempted by examination of the interaction of science policy organisations and initiatives with the science they seek to influence.

In most cases the research councils are also responsible for the design and funding of large cross-disciplinary *programs*. The programs are some of the most cost-intensive instruments used to induce and facilitate cross-disciplinarity. The contributions gives examples of a number of different programs, predominantly social sciences programs, and it was evident that there are major variations in terms of funds, themes, management, out-put expectations etc. There is some doubts on the ability of large-scale cross-disciplinary research programs to develop successful cross-disciplinary collaboration beyond the rudimentary form of taking notice of each other, and Niesen was of the opinion, that the larger the program, the less likelihood of realising successful cross-disciplinarity.

Another group of very visible instruments are the variety of *specialised institutions* with different forms of cross-disciplinarity as a specific and explicit objective. The European cases studied vary a lot in terms of organisation, autonomy, size, funding, research-focus etc. Some of the institutions are more or less autonomous, while others are smaller units within larger, more traditional institutions (see more about the details in Aagaard and Siune (ed.) 2002).

The examples range from ZIF in Bielefeld, that invites researchers from different disciplines in residence for the achievement of a common project - to another and more frequently used way of approaching cross-disciplinarity exemplified in the institutes for Advances Studies (represented in this conference by the Wissenschaftskolleg Berlin among others), that brings together, in residence, researchers from different disciplines with individual projects thereby provoking 'spontaneous' interdisciplinary contacts. Another variation is the French Maison des Sciences de l'Homme, which establishes or receives, for limited periods of time, experimental groups seeking to determine new directions and methods for research in the social sciences. MSH encourages dialogue among researchers, through symposia, round tables, workshops and the Internet. It is also concerned with the collection, publication and dissemination of scientific information though the means of its publishing house and on variety of scientific levels. Within these different mixes of instruments and measures are used. They vary from different forms of research groups, smaller programs and different forms of projects - to workshops in varying sizes and forms, task-forces and collaboration between arts and science etc.

Different types of *Management* are important instruments, that relates to all kinds of cross-disciplinarity, from the biggest institutions and programs to the smallest projects. Research management is in itself a difficult and highly debated issue, and when the problems of managing researchers with different disciplinary backgrounds are added, the potential barriers and difficulties become even bigger. In the project report different concrete examples of management initiatives were described (Scheuermann in Aagaard and Siune (ed.) 2002, pp 75-78).

Among the information tools recommended for research managers Scheuermann advocated for corporate communication as a practical tool to start discussions and to promote communication at all levels, because it reflects on the communication between the members of the program and between the program and its environment in an integrated approach, and members of such programs should be trained in using communication tools and should be informed about the specific corporate communication in the program. Another important argument was, that management of large-scale cross-disciplinary programs is a specific task and not the task of the researchers. Consequently Scheuermann emphasised, that program-managers need specific training in science/research management. This argument was supplemented by Thurn, who argued that in large research units the need for "research management" can be so demanding that the possibilities for the responsible director to personally participate in the scientific work might become narrowly limited.

Other less tangible management qualities were mentioned in a number of other contributions. Rayner suggested that experience with operational problems and challenges of building collaboration across disciplinary boundaries counts, when it comes down to conflict resolution and motivation. He argued, that often the role of management is pastoral or therapeutic as much as it is intellectual and scholarly. Similarly Page (op.cit) pointed to a number of different roles and responsibilities of a program-manager, and emphasised how different phases of the running of a program requires different management skills.

Another group of instruments are the direct and indirect *incentives* at the level of the individual researchers. There is a very limited use of this instrument in terms of formal recognition in titles, prizes, career-opportunities and resources for cross-disciplinary scholars, but it is nevertheless an important measure to increase the attractiveness of this operational principle.

Evaluation as an instrument must not be forgotten. It is a key instrument and probably one of the most debated in relation to cross-disciplinarity. Ex-ante as well as ex-post evaluation remains an unsolved problem in the management of cross-disciplinary research. There are no widely accepted criteria for evaluating collaborative work and the prevailing disciplinary standards are often inappropriate. Conventional productivity measures such as the number of publications and citations do not readily apply. Often cross-disciplinary research results in fewer individual publications, more collective authorships outside mainstream disciplinary publications, and peer group evaluation is difficult to achieve. The problems related to these methods were one of the issues, which deserved a more thorough analysis. The problem of evaluation has been explicit in the debate concerning the Danish Research Council Structure. In this case the opponents of a cross-disciplinary research council structure argued, that in their view new scientific departures did not happen *between* traditional disciplines, but instead by combining approaches, methods and theories from different disciplines. Therefore, it was argued, it was still necessary to use the well-established disciplinary quality-criteria as a starting point for funding procedures. In their view cross-disciplinary initiatives would in most cases require a simultaneous evaluation in different disciplinary research councils, and these procedures were already well integrated in the disciplinary research council system, while the alternative would be evaluation in a number of subcommittees. Disciplinary assessment- or evaluation-structure could be a barrier to research across disciplinary boundaries, as the case of the Higher Education Funding Councils' Research Assessment Exercise (RAE) illustrated. The allocation of the research element of the first level, baseline funding to British Universities are determined on the basis of disciplines or disciplinary sub-fields, and according to Caswill (op.cit), this is by many perceived as a barrier for increased cross-disciplinarity.

Valdalbero and Osorio (in Aagaard and Siune (ed.) 2002) listed the evaluation-methods used by DG-research in the only contribution, where specific evaluation criteria were described. Not only scientific and technological quality are evaluated in DG-Research, but also aspects such as management skills, the quality of the partnership, which is being set up, community added value and contribution to EU-policies, contribution to Community social objectives and economic development and scientific and technological prospects. All these criteria are born in mind when external experts (coming from different countries, backgrounds and disciplines) evaluate different proposals. Their relative importance is also considered and thus, a weighting factor is included in the overall process. They argued, that many variables from different fields and domains and many stakeholders are taken into account in order to guarantee that the results of the investment efforts coming from the Community funds are maximising their efficiency.

It is strongly debated if and how some of these aspects can be evaluated in practice, too many and too specific evaluation criteria could be a barrier to truly innovative and path-breaking research.

The conflict between the well-established and respected disciplinary quality-criteria and the criteria explicitly designed to evaluate cross-disciplinary research, and underlined the fact that a balance is difficult to achieve.

So far we have found no clear patterns of the use of different instruments seem to be visible across Europe when we look at cross-disciplinary evaluations. The instruments are used in different forms and in different mixes across the represented countries, but the contributions nevertheless show elements of convergence. This is not unexpected, as actors in situations of great uncertainty tend to search for ready-made models of what to do, and imitate what appears to be a successful measure by someone else in a similar situation ((ed) Siune and Kalpazidou Schmidt 2003).

Terminological confusion

The question of the definitions of central terms is another important issue that needs to be addressed when discussing crossing of disciplinary borders in research, not the least for management and planning purposes. Multi-disciplinarity, pluri-disciplinarity, cross-disciplinarity, inter-disciplinarity and trans-disciplinarity are just some of the terms used to describe different forms of research collaboration crossing disciplinary borders, and unfortunately these terms are not always used in a systematic or even logic way.

The terminological problems have been give attention in the project report (op-cit). But it is beyond the scope of this article to go into that discussion. Similarly it is beyond the scope and ambition of this article to come up with a new set of definitions or choose one set instead of others, but the confusion in definitions is an important element, as a clear terminology, of course, is a prerequisite for reducing the uncertainty. The more integrated the collaboration of different approaches, methods and theories, the bigger the barriers and potential problems, that have to be overcome, will be. On the other hand, it has been argued that the more integrated the collaboration of approaches, theories and methods, the bigger the likelihood of creating not only more economically or socially useful knowledge, but also more scientifically interesting knowledge. Consequently it is important for decision makers, administrators as well as for practitioners to make the central terms crystal-clear to avoid misunderstandings. It is similarly important to be aware that the demands in terms of structures, instruments, management, time etc. are different for different forms of cross-disciplinary research activity.

What to learn?

The most important recommendation is, that projects should be problem- or topic-driven. Poorly defined, vague, abstract, or grandiose problem formulation will not grab and retain the focussed interest of the researchers.

Secondly participants shall be selected for a combination of confidence in their disciplines of origin and openness to other ways of viewing the world. This model of confident, but permeable, disciplines was in a number of the contributions perceived as absolutely essential to interdisciplinary success.

The third factor is size. A project needs to have a critical mass of participants from the “minority” disciplines in order to attain a balanced collaboration, but at the same time the importance of small units is emphasised based on European wide experiences. This recommendation is also in line with previous studies, where a number of participants between 5 and 10 and a balance of disciplinary perspectives have been described as the optimum situation (Klein, 1990, 129).

Time for confidence building is the fourth recommendation. Cross-disciplinary research requires more time than mono-disciplinary research. This additional time is among other things required to assimilate each other’s expertise and disciplinary language.

The fifth recommendation is a supportive reward structure. Cross-disciplinary research lacks the majority of incentives of traditional disciplinary research in the form of rewards, titles, career opportunities etc., so different incentives are essential to attract qualified researchers.

An influential audience is the sixth pillar for cross-disciplinary success. Contrary to disciplinary scholars, who traditionally have themselves as the primary audience, cross-disciplinary researchers are often lacking a clearly defined audience. Rayner argued, that no matter how intriguing the research problem or its potential outcome, it is not likely to proceed very far or fast unless the participants see themselves as addressing an audience that could act on it. Since no one likes to perform to an empty theatre, identifying an audience that can act on the research is an important ingredient in its success. This argument was supplemented by Thurn, who argued that research fellows in a problem-oriented research unit will find that their success depends not only on the integration of their work into the overarching research program, but also in the recognition of their achievements by an external peer group. This tension between inward and outward orientation will be stronger the more the type of research undertaken in a given institution deviates from “normal” research done elsewhere.

Having experienced weaver (interdisciplinary specialists) on the team is the seventh pillar for interdisciplinary success. Rayner argued, that prior experience with operational problems and challenges of building collaboration across disciplinary boundaries is needed. Other essential management abilities are conflict resolution and an ability to keep people engaged when they become frustrated with other participants. Furthermore it is a matter of being aware of and able to make the initial connection between threads that have been spun in isolation from another. The role of the manager is often pastoral or therapeutic as much as it is intellectual and scholarly. In this respect it is very much in the realm of craft skill, and is often hard to evaluate. In addition to these personal abilities, a number of management instruments with a specific focus on information and communication can be recommended. A high degree of flexibility is needed in the management of cross-disciplinarity. All in all across European experiences there is an agreement that managing cross-disciplinary research demands more management skills than managing uni-disciplinary research.

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2.4. Research Management Processes in the Context of Changing Research Policies - *Development contracts and management reforms at Danish universities*

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Introduction

The research project presented in this English summary of results, deals with the interplay of research management and research policy, or rather research management within a framework of research policy. To analyze changes in connection to this interplay, the project focuses on two political initiatives first officially introduced in 1998/99, and explores the impact of these initiatives on research management processes at the Danish universities.

The political initiatives in focus of the analysis are the so called development contracts, as well as the proposals that followed in the wake of these, anticipating the 2002 management reform and 2003 university act: The establishment of university boards, with a majority of external members as well as external chairman; and a transition from a situation in which the university managers were formerly recruited on the basis of democratic election, within and from the group of scientific staff in the universities; to a situation in which managers at the universities are recruited by appointment from the newly established boards, and employed on a limited tenure. These proposals, which were initially put forward by a number of actors and communities of interest (including The Danish Council for Research Policy, representatives from industry, as well as a number of political parties), were officially taken up by what was then known as the Ministry of science – now the Ministry of Science Technology and Innovation- where they formed part for the basis of what later came to be known as the 2002 management reform, which June 1st 2003 passed into legislation as a new law for the Danish universities.

The development contracts take on the shape of mutually binding agreements between each of the Danish universities on one hand, and the Ministry of Science Technology and Development as well as the Ministry of Education on the other, on a number of formulated objectives, that the universities commit themselves to achieve within a four year timescale. These have, to a large degree, been formulated by the universities themselves, at least at the initial level of agreement, but the goals also had to be cleared by the management situated at the political level. It is more blurred what the mutually binding part of the contracts means, with respect to the commitment on the side of the politicians in charge.

Through a closer inspection of the development contracts and the proposals described above, this research project sets out to illuminate a number of the central questions and problems, that arise in relation to the dynamic interplay between research management and research policy; the central research-questions pursued in the project being:

- To investigate perceptions among managers situated at different levels at the universities towards the development contracts and the proposals that followed in the wake of these, and pursue the question of how these political initiatives affect research, researchers and research management processes at the universities.

- To describe the development contracts as well as the 2002 university act as political initiatives, and illuminate the incitements on which these initiatives have been sought realized at the universities.

- To investigate which actors and communities of interest have sought to gain influence on the political agenda, what particular questions and problems they have sought influence on, and what bias these expose in the process of policy-making.

- To set up a consistent theoretical and methodological framework for an anthropological analysis of processes of change in the interplay between research management and research policy in the context of the Danish universities.

The nature of these questions pose a number of challenges to the theoretical and methodological design of the research project, such as: How can changes be analyzed while in the midst of them; how to approach the exploration of questions that are both multi-complex, multi-sited, and situated within a context of ever changing process, without entering into the pitfall of employing an analytical perspective that is too simplistic to supply a detailed account of the questions and problems under investigation?

Without entering into any deeper account, it seems fertile at this point to briefly outline a few features of the theoretical and methodological design underlying the present research project.

Theoretical and methodological design of the project

For its theoretical and methodological inspiration, this project turns towards what Chris Shore and Susan Wright have called the "Anthropology of Policy" (Shore, C. & Wright, S. (ed.) 1997), and to Fredrik Barth who, among other areas of interest, is concerned with the establishment of an; "Anthropology of Knowledge" (Barth, F. 2002). A combination of these two lines of anthropological inquiry forms the main framework for the theoretical and methodological part of the analysis pursued in this research project.

The theoretical and methodological inspiration from the Anthropology of Policy means that a critical perspective on governance and power is applied in the analysis. The argument put forward by Chris Shore and Susan Wright is that policy has become an increasingly organizing principle in contemporary societies, shaping the way people live, act and think. Policies influence the way individuals construct themselves as subjects, acting both on and through people as free and rational agents. But if policy is a tool of government, the authors argue, it is equally a tool for studying government, and for tracing the links between different sites, agents and levels within the policy process. (Shore, C. & Wright, S. (ed.) 1997)

Chris Shore and Susan Wright (re-) conceptualize the field of investigation for an Anthropology of Policy; "*not as a discrete local community or bounded geographical area, but as a social and political space articulated through relations of power and systems of governance*" (Shore, C. & Wright, S. (ed.) 1997:14) This approach treats "political communities" as not just rhetorical, but contested political space. From the prism of different perspectives on any particular policy issue, the questions addressed are; "*Whose voices prevail*?" and "*How are their discourses made authoritative*?" (Wright 1995:79).

In order to answer these questions, Chris Shore and Susan Wright suggest, that we turn our attention to the keywords employed by actors and communities of interest in the naming and framing of the central questions and problems, and follow the keyword and the clusters they form in the analysis. The analysis of keywords focuses the attention on the processes whereby central keywords migrate between contexts and are used in new ways. When keywords enter into new contexts, old meanings are often pushed to the background, or existing meanings are expanded in new and often unpredictable directions. When keywords migrate to new contexts, their relation to other keywords are also changed, and new clusters of meanings are formed. These, according to Chris Shore and Susan Wright: *"provide the threads from which discourses and ideologies are woven and, when successful, form the conceptual bedrock upon which new institutions are founded and acquire cultural legitimacy"* (Shore, C. & Wright, S.2000: 60).

One central focus of interest in the work of Chris Shore and Susan Wright, is the rise of Neo-Liberalism in British higher education, and the following introduction of a particular mode of governance known as "new public management". Central to this mode of governance is an emphasis on audit and accountability in the form of political technologies. Political technologies according to Dreufuss & Rabinow: "…*advance by taking what is essentially a political problem, removing it from the realm of political discourse, and recasting it in the neutral language of science*" (Dreyfus, H. & Rabinow, P. 1982: 196). When political technologies are used in the form of medias of representation and communication that promote audit information, such as for example the development contracts, political technologies take on the form of audit technologies.

A view on audit technologies and the accountability on which these feed, is employed in the analysis of the development contracts for the Danish universities, through a perspective of the central keywords and clusters that are formed in the process of creation and implementation of the contracts and the 2002 university reform.

Audit and Accountability should be recognized as keywords, but at a more theoretical level of the analysis that might be called a 2nd order of analysis; which is of a more interpretive nature, as compared to the more descriptive nature of the 1st order of analysis, which is pursued in the presentation of the empirical material. These levels of analysis should be recognized as a question of the level of abstraction and proximity towards the empirical and the theoretical data.

In combination with a view of the field of investigation as a political, rhetorical and contested space made up of relations of power, that can be analyzed through a perspective on keywords and the clusters that are formed, this research project draws on inspiration from the Anthropology of Knowledge, as formulated by Fredrik Bart (2002). Through a perspective on knowledge, and the particular traditions within which tradition-specific knowledge is sustained, the inspiration from Barth is intended as an attempt to strengthen the theoretical and methodological foundation of the empirical analysis of communities within the discourses of power under investigation.

Knowledge, Barth argues, always has three faces: "*First, any tradition of knowledge contains a corpus of substantive assertions and ideas about the world. Secondly, it must be initiated and communicated in one or several media as a series of partial representations in the form of words, concrete symbols pointing, gestures, actions, and thirdly, it will be distributed, communicated, employed, and transmitted within a series of instituted social relations. These three faces of knowledge are interconnected".* (Barth, F; 2002: 3) One of the strengths of the perspective on knowledge outlined here is that at the same time as these faces are interconnected, according to Barth even mutually determining, a focus on these three aspects of knowledge respectively, is analytically separable.

The items of knowledge that are cast in the medias of representation and communication is positioned within particular traditions of knowledge, and, according to Barth, an investigation of knowledge through an analysis of the aspects described above, should thus turn to an inspection of the underlying criteria of validity, sustained and employed within particular traditions of knowledge. These criteria for validity, Barth argues, arise: *"...through the effects on action of the constraints embedded in the social organization – the distribution of knowledge, its conventions of representation, the network of relations of trust and identification, and instituted authority positions of power and disempowerment. But they are also affected by constraints that arise from the properties of the medium in which the knowledge is being cast, which affect the ideas that can be conveyed through forms of representation that are felicitous, limited, or impossible for those ideas in that medium"* (Barth 2002: 3).

The relation between research management and research policy in a historical context

The problematic relationship between research management and research policy is not new. This has been the object for debate for a hundred years or so; typically centralized around a dual question such as that of autonomy versus heteronomy in the academic community vis-à-vis the political system; depicted as more or less homogeneously cultural groups oppositely situated on each side of the dichotomy of what is considered internal as opposed to external, in relation to the position of such dimensions as the universities, academia and science. This more or less simplistic perspective is often all to readily adopted when actors and communities of interest in the policy processes address such questions as the role of science in society.

Part of the historical and ideological background, that still seems to influence the views and ideas that are employed and communicated in present debates about research management and policy, is perhaps most clearly formulated by Weber in two lectures he gave at the turn of the last century. In these lectures, which were later made into the articles “Science as a vocation”, and ”Politics as a Vocation” (Gerth 1958: 77-159), Weber argues that a sharp division between the political system and science should be maintained.

A central point to the argument put forward by Weber is that research implies the search for truth, which makes research an activity of objective rationalism, as opposed to policy that according to Weber is, and should be, an activity of rationalism based on values, in which elements of subjectivity have significance. On this background Weber argues that science and politics should be organized separately, since the forms of ethics and rationality found within the spheres of science and politics respectively, according to Weber, are incommensurable.

Academic freedom, and the independence of other interests in the process than those of pursuing truth along the lines of scientific disciplinarity itself, are thus central values to the traditional academic perspective on science and its role in society. Another central element in relation to the so called traditional perspective on science is the reliance on a concept of quality[27] of (the results of) the research that rests on criteria of validation such as originality, stringency and plausibility; the relevance of science to surrounding society not being central to the evaluation of the quality of research.

This is part of the historical background for the distinction between the so called traditional societal perspective on science and the role of science in society, as opposed to the so-called traditional academic perspective on science and its role in society. This distinction is based on the dualistic positioning of attitudes and points of view along lines of what is considered internal, as opposed to what is considered external, with regard to the scientific community.

Some characteristics of the so called traditional societal perspective on science and its role in society is that:

- Science is viewed as a means of achieving political and societal objectives; research is legitimized by its economic and societal significance.
- It is possible to influence the development and direction of science through the internalization of societal objectives in the research-process – externalism and market-pull conceptions.
- Science should support policy – science for policy.

[27] Though the concept of “quality” is more often implicitly implied than consciously formulated and communicated as a keyword; when the persons doing the research address such questions as those of the criteria of validation of research -situated within particular disciplinary traditions of knowledge.

Some characteristics of the so called traditional academic perspective on science and its role in society is that:

- The objective of science is to produce acknowledgement for the sake of acknowledgement; the search of truth and accumulation of knowledge is the primary aim – research is legitimized by its cultural significance.
- It is not considered possible to influence the development and direction of science, since processes of science internally steer the development of science – internalism and science-push conceptions.
- Research policy should create a good framework for science – policy for science.
  (Kjølhede et. al 2000: 7).

These two (stereotyped) perspectives on science and its role in society are most often depicted as the opposition of each other; not the least in the public debate about research management at the universities. Nevertheless, these perspectives both exist as a mixture and side by side, internally as well as externally, in relation to the universities and the academic community in general.

Besides the use of an internal/external dichotomy in the attempted positioning of attitudes and ideas, this distinction is also deployed as a means of positioning the actors and communities of interest, along lines of their institutional and organizational standpoint.

This use is employed in the way Nikolaj Petersen (1997) addresses the question of state interference in Danish higher education. This material gives an overview of the development of the relation between research management and research policy in a historical context, through an inspection of reforms and university reforms and acts. Nikolaj Petersen identifies three models of internal organization, and three models of external control of the universities, that run along (-an institutional and organizational meaning of) the internal/external dualism. These are with regard to internal organization; 1) Meritocracy, 2) Democracy, 3) Professionalism: - And with regard to models of external control; 1) Laisser-faire policy, 2) Government control – and, 3) Societal control.

The relation between these models of internal organization and external control is analyzed in context of the university reforms and acts that help shape research management and research policy, and the development depicted using this perspective is one in which:

- The pre-1970 –period is characterized by the combination of internal meritocracy and external laisser-faire policy.
- The 1970/73 acts meant a transition to a situation characterized by the model of internal democracy and external maintenance of the laisser-faire policy: This regime of laisser-faire policy started to change in favor of more government control on the external side, from the 1980s.
- Through the 1993 university act, the internal organization came to be characterized by the model of professionalism, and externally by the model of government control.

The appropriateness of the dualistic perspective on autonomy and control is questioned in the analysis, as it is with respect to the boundaries that typically separate that which is situated internally, from that which is positioned externally, in the contemporary context of research management and research policy at the Danish universities.

An approach to the questions and problems addressed that is sensitive to the distinction of the institutional and organizational positioning of the actors and communities of interest, and the positioning of these along lines of the perceptions and standpoints they express, is pursued in the analysis.

Abstraction at some level, in relation to the organizing concepts and categories, is off course necessary for the description and understanding of the complex and changing questions and problems discussed. But the

distinction between lines of the internal/external dichotomy does not always seem to be clear, with respect to the way actors and communities of interest position each other in the public debate about the management at the universities.

Qualification of the concept of research management and presentation of a framework for analysis

The perspective on medias in the form of audit technologies as vehicles for accountability are closely related in the analysis with the concepts of responsibility and management; since the former concepts describe the process of, and tools for, legitimating the latter. On these grounds the analysis pursued in this project raises two sets of interrelated questions and problems: Who are being held responsible and accountable by whom, And, what ends are they being responsible and accountable towards? Or as formulated by Susan Wright in a personal meeting: *"Who is defining what? - For whom? – And with what consequences?"*

Some of the central assumptions underlying this approach in the analysis are, that the concept of (research-) management denote a particular area of competence and responsibility, which the act of performing research management is directed towards; that research management is not a goal in its own right, but a means of achieving other (- ex. political or disciplinary) objectives and, that such concepts as "quality" and "efficiency" is considered keywords that denote objectives and values that are pursued, at least to a general level, in relation to all other goals pursued (- disciplinary, political or other).

Model of analysis	**Management and responsibility**	**Medias of representation, and audit technologies**	**Quality; - and other empirically grounded keywords**
Structural level	**Political management** The parliament The Government The ministry	**Development contracts**	**Quality at the structural-level**
Level of process	**Administrative management** Headmaster Deans Head of departments		**Quality at the level of process**
Level of results	**Operational management** Scientific staff	**2002 management reform***	**Quality at the level of results**

* Also evaluation, bencmarking, peer-review, and ranking in the form of counting the number of publications or citations, are found to be of relevance in context to the empirical material, though this list of medias and audit-technologies is by no means exhaustive, when it comes to research management processes within the framework of research policy.

Summary of results from the empirical material in the form of an analysis of political documents and articles from the public press

The interrelationship between research management processes and research policy in the making is analyzed through a perspective on the keywords that rise to prominence and clusters that these form: In relation to the establishment of the development contracts for the universities; and the proposals about the establishment of university boards, with a majority of external members as well as external chairman; and a transition from a situation in which the university managers were formerly recruited on the basis of democratic election, within and from the group of scientific staff at the universities; to a situation in where managers at the universities are recruited by appointment from the newly established boards, and employed on a limited tenure.

The empirical evidence for the summary of the results presented here are delivered in the report in the shape of a dynamic ethnographic description of the questions and problem, presented in the reading on a 1st order of analysis of the public debate, concerning research management and research policy - through a perspective on development contracts and the proposals that followed in the wake of these.

The objective in this part of the analysis is dual:

- To describe the development contracts as well as the 2002 university act as political initiatives, and illuminate the incitements on which these initiatives have been sought realized at the universities.
- To investigate which actors and communities of interest have sought to gain influence on the political agenda; what particular questions and problems they have sought influence on; and what bias these expose in the process of policy making.

The analysis of the public debate about research management and research policy demonstrates how a range of actors and communities of interest seek to gain influence on the political agenda in relation to the questions and problems that are raised in the public debate. It also shows that the variety of questions and problems raised in the process of policy making, in relation to the political initiatives under investigation, is extensive.

The analysis of which actors and communities of interest have sought influence on the political agenda; what particular questions and problems they have sought influence on; and what bias these expose in the process of policy-making, is only treated partially in this part of the analysis; concentrating here on the identification and positioning of actors and communities of interest according to the lines of their institutional and organizational affiliation, and the mapping of these in relation to the questions and problems they engage in.

Without going into further detail about these categories; the following categories of actors and communities of interest are identified, within the discourse under investigation: The level of political management; the level of administrative management; the level of operational management; disciplinary communities of interest; intermediary bodies; the political system; as well as other actors and communities of interest.

The public debate about research management and research policy represents itself as one that is characterized by a relatively high degree of confusion between the positioning of actors and communities of interest along the lines of their institutional and organizational affiliation, and the values and ideas these actors and communities of interest express and expose in relation to the vast range of questions and problems addressed in connection with the development contracts and the proposals later found in the 2002 management reform and the 2003 university act. Thus the complexity of reality that is found in the field of investigation is only to a minor degree reflected in the debate concerning research management and research policy itself.

The public debate concerning research management and research policy is furthermore characterized by significant obscurity and muddiness, as a consequence of the lack of substantial information with regard to the substance and shape of the development contracts, from the side of the politicians in charge.

The aim of describing the development contracts as well as the proposals underlying the 2002 university act as political initiatives, and explore the incitements on which these initiatives have been sought realized at the universities is, as noted above, delivered in the final report[28] in the shape of a dynamic ethnographic description of the questions and problems, presented in the reading on a first order of analysis of the public debate. This is done through the reading of the three official political documents presented by the ministry of science from respectively: 1998 – where the proposal to formulate development contracts for the universities was presented; over 1999 – where the process of negotiation of the development contracts is taking place, to; 2000 - where the established contracts are presented.

The reading of the public debate concerning management-research and management-policy shows a relatively high degree of congruence between the views put forward by representatives from the category of disciplinary communities of interest, and the reasons given by the minister of science for the implementation of the development contracts for the universities: These disciplinary communities of interest, as well as the minister of science, at that time Jan Trøjborg (S), criticizes the management at the universities for not functioning satisfactory. The critique is, among other things, directed toward the claim that the management does not posses the necessary competence when it comes to prioritizing recruitment of academic staff as well as areas of research. This lack of competence, according to the critics, have led to a fall in the quality at the universities.

The management at the universities is also criticized for not being sufficiently obliging towards the interests of society and industry in the application of university research. On these grounds the disciplinary communities of interest argue for the strengthening of the management at the universities, and the minister of science agrees. This is part of the background on which the desire to establish development contracts for the universities rests. In connection with this, a number of parameters of quality in connection to the range of formulated objectives that the universities, in cooperation with the responsible ministries, formulate and set up, and thus commit themselves to employ and fulfill.

The discussions about the relationship between the universities and society have, to a large degree, centered on questions and problems in relation to the interplay between universities and industry. The minister of science, on his side, is met with critique from parts of the public press, and from the research management situated internally at the universities, for playing into spy hands with the interests of industry; and for wanting to establish a form of management that to a higher degree is concerned with “productivity” and “efficiency”.

This is highlighted by the critics as problematic, not the least with regard to the concepts of academic freedom and the independence of the universities. The reading of the debate shows considerable insecurity and skepticism with regard to the parameters of quality and criteria of validation underlying the development contracts and the proposals that followed in the wake of these.

From the side of the actors and communities of interest situated within the category of “disciplinary communities of interest”, the research policy carried out is thus criticized for being inconsistent, arbitrary, and characterized by the lack of coordination between the Ministry of Science and the Ministry of Education. This according to the critics, not only affects the way science is financed, in a negative direction: It is also problematic in relation to the establishment of the framework of a research management at the universities that is oriented towards the results of the effort made.

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[28] Forskningsledelse i en forskningspolitisk kontekst - *Udviklingskontrakter og ledelsesreformer på danske Universiteter*, P. B. Andersen, Report 2003/10, The Danish Institute for Studies in Research and Research Policy - In Press.

The criticism of the practical research policy is also directed towards the plan to establish development contracts for the universities. This criticism is not only delivered by actors and communities from within the universities and parts of the public press, but also from the political opposition for putting too much emphasis on the commercialization and utility value of university research at the expense of “free” basic research.

Quality, efficiency, production, productivity, responsibility, accountability, decentralization, empowerment, flexibility, transparency, evaluation, measurements, competition, commercialization, utility and even exploitation is, just to mention a few, some of the keywords that dominate discussions about such activities as; the development contracts, research management and research policy, the relationship between universities and society, evaluation of universities, research and researchers, benchmarking, administration and economy etc.

One central point in relation to this is, that the ideas, viewpoints and attitudes exposed in the reading of the public debate are not only positioned along the lines of institutional and organizational affiliation, but also within specific traditions of knowledge. Further more, these ideas, viewpoints and attitudes are situational - applied in relation to specific sectors and items of knowledge.

The reading of the public debate concerning research management and research policy also illuminates how questions and problems related to new political initiative such as the 2002 university reform gain prominence as central concerns - shaping public debate - whilst the implementation of previous media of communication and audit technologies, such as the development contracts, are still at an initial state. The result being one of uncertainty and insecurity being installed among those affected.

The public debate concerning research management and research policy presents itself as one in which actors and communities of interest are mutilating each others point of view, rather than one characterized by an emphasis on communication and sensitivity between the levels of management (and levels of expert knowledge), based on a foundation of mutual trust towards each other.

Results from the empirical material in the form of an analysis of eighteen qualitative interviews conducted at Aarhus University and Copenhagen University
The summary of the interview analysis comes in two parts: One that explores questions and problems related to the development contracts, and one that deals with the 2002 management reform.

Summary of the results from the interview material concerning the development contracts
One of the questions pursued in the interviews conducted is; who has had influence on the shape and content of the development contracts, and; whether the managers and members of the scientific staff interviewed are satisfied with the influence they have had on the contracts, or not?

The interview material shows a great deal of difference in the way the process of formulating the development contracts has been carried out at the institutions under investigation as well as with regard to the degree to which the scientific and managerial staff situated at the different levels of management have been involved in the process of delivering input in relation to the contracts.

A vast majority of the persons interviewed share the view that the universities themselves, to a high degree have formulated, and thus more or less decided, the objectives set up in the development contracts. The general tendency in the interview material thus indicates that the management and scientific staff in general have been satisfied with the degree of influence they have had on the formulation of the development contracts, and the supplementary contracts that followed.

The replies to the question of what the establishment of development contracts has meant for the management at the universities, indicate that these are not attributed any high degree of significance as an instrument of internal management, at least not at the University of Aarhus. The managers situated at the

higher levels of management at the University of Copenhagen seems to be generally more positive towards the potential of the development contracts as a tool for internal management. The Headmaster, as well as one of the Deans, at Copenhagen University thus holds the view that the establishment of the development contracts have lead to a general strengthening of the administrative management situated at the level of process.

Several of the respondents point to the fact that, the objectives formulated in the development contracts to a large degree is covering activities which the universities already had on the drawing table before the development contracts came into existence and in some cases activities, which the universities had already initiated on their own. This seems to indicate that the development contracts should not be attributed any high degree of significance at the concrete level of change, i.e. in regard to the initiation of initiatives that are in actual fact novel. A number of respondents express the viewpoint, though, that the development contracts have played an active part in speeding up the process of initiating the objectives and activities formulated in these contracts.

The interview material thus suggests, that the effect of the development contracts on the universities primarily is to be found at a more diffuse level of influence, as the contracts are attributed "consciousness-raising" significance by a number of the persons interviewed. In the interview material, this is related to the fact that the objectives of-, and activities on the universities, to a higher degree than before is in focus; and that this contributes to the strengthening of the task of formulating long term strategic planning for the future development of the universities.

The supplementary contracts that followed in the wake of the development contracts mark a concretization of objectives and activities, in relation to initial contracts. The objectives and activities formulated in the supplementary contracts thus generally take on a more specific character, and the relation between the areas of effort and the allocation of resources is closer than it was the case in relation to the initial contracts. At the same time it is clear that the responsible ministries have sought to gain a higher degree of influence on the objectives and activities formulated in the supplementary contracts than was the case in relation to the initial contracts.

One central question raised in this connection is, whether the objectives and activities formulated in future contracts are going to be further concretized and specified, and whether this will lead to a situation in which political interests gradually gain increased influence in the strategic planning of the development of the universities. Another central question in relation to this is, whether this situation in the long term will lead to a narrowing of the objectives and activities of the universities.

Several of the persons interviewed emphasize how the development contracts have been a contributing factor in the increase of tasks of a more administrative character, assigned to the university management. The explanation for this is that the development contracts have not replaced other forms of audit technologies, but have instead added yet another one to the pile of audit technologies already implemented at the universities.

The interview material in connection to this suggests, that the development contracts do not only have a "consciousness raising" significance internally at the universities, but that they also have this significance externally, among the politicians. Thus, the development contracts are emphasized as an act of primary significance in relation to the legitimisation of the spending of resources on activities at the universities, towards the political management situated at the structural level of analysis[29].

One central problem that has also been raised in the interview material, in relation to the development contracts as a way of recording and legitimizing, consists in the fact that many of these objectives have been formulated in such broad and loose terms, that in reality it is difficult to determine the degree of achievement

at the universities regarding the objectives in the contracts. One problem that is pointed out in connection with this is, that it will thus probably be fairly easy for the parties involved in the development contracts to claim that they have achieved the objectives written into the development contracts; or to claim that other parties in the contract have not achieved these objective; if this is what they wish. Several of the interviewees have, in connection to this, pointed out, that this has been a conscious, strategic move from the side of the universities, in order to avoid any detailed degree of interference from the side of the politicians.

Another problem pointed out by some of the interviewees, in relation to the development contracts as a medium for the formulation, communication and recording of (the degree of-) achievement of the objectives written into the contracts, is the problems associated with the formulation of collective objectives for research itself. Objectives in relation to the research carried out at the universities, is thus emphasized as an area of competence and responsibility that relate primarily to the individual researcher - as an expert on her/his specific (disciplinary) field.

The fact that the development contracts only to a limited degree describe objectives in close relation to the specificities of particular research, which, by a vast majority of the interviewees, is categorized as one of the core competences of the universities, and emphasized as a contributing factor to the fact that the fulfilment of objectives written into the development contracts are often perceived of as being of a more secondary character[30]. Furthermore, several of the interviewees have noted how the development contracts hold the risk that a focus on the core competences at the universities is displaced in favour of a focus on the range of activities of a more secondary and administrative character.

Also the lack of connection between the objectives written into the development contracts, and the resources to finance the realization of these objectives, is emphasized by several of the interviewees as problematic. This circumstance, in combination with the fact that the development contracts are not juridically binding contracts, has contributed to create insecurity and scepticism with regard to the question of whether or not the ministries in charge will fulfil the expectation of the universities. On this background several of the interviewees point out, that the incentives for the establishment of the development contracts have been limited.

The general attitude towards the development contracts in the analysis of this part of the interview material suggests that the contracts are not viewed as an expression of a higher degree of government-control of the universities. On the other hand, only very few interviewees have expressed the view that they have experienced a higher degree of freedom or autonomy, as an effect of the development contracts[31].

Summary of the results from the interview material concerning the 2002 reform
The reading presented here focuses on a range of elements that formed part of the provisional proposal for a management reform for the universities, as presented by the government, at the time the interviews were carried out.

One of the central elements in the provisional proposal for a management reform, consisted of the suggestion that the administrative management situated at the level of process in the future be appointed and recruited on a limited tenure. This part of the provisional proposal fundamentally deals with the mode of selection and recruitment of the administrative level of management at the universities. These questions are in the interview material linked to the discussion of whether the management at the administrative level should, in the future, be recruited from within the ranks of personnel situated at the universities, or whether these should be imported from elsewhere. The question of the mode of selection and recruitment of the administrative level of management, and the question of where the candidates for this level of management

[29] Referring to the model of analysis presented p. 69.
[30] As implied in the model of analysis presented p. 69, a distinction is made, between the managerial tasks attributed the research management at the different levels, through a perspective on the areas of responsibility and competence that relate to these.

should come from, are two separate questions, though. The confusion of these questions is just one expression of the uncertainty and insecurity that has characterized the debates about the 2002 management reform. This should partly be recognized as a consequence of the lack of plain and substantial information in connection to the provisional proposal for the 2002 reform, put forward by the ministries in charge.

In the interview material it is pointed out that there is a number of problems, as well as number of advantages, related to the mode of selection and recruitment in which managers at the level of process are elected by, and from, the scientific staff at the universities: Just as it is pointed out that there are problems as well as advantages related to the mode of selection and recruitment, in which the management is in the future appointed and recruited on a limited tenure.

The attitudes presented in this part of the interview material points to the fact, that the questions concerning the mode of recruitment and selection of the administrative management situated at the level of process; and the questions concerning where these managers should come from, should be treated as separate and level specific. In relation to this, the interview material demonstrates a need to clarify which managerial tasks the different levels of administrative management is expected to take care of, and which qualifications and competences the different levels of administrative management, within the level of process, should posses, in order to solve the tasks assigned in an optimum way.

The question of what qualifications and competences constitute the suitable grounds for the selection and recruitment of the administrative management at the different levels within the level of process in the future is, in the interview material, treated as a question of “professionalism” and “disciplinarity”[32]. The vast majority of interviewees note how the management at the level of Headmaster, the deans, as well as at, the heads of departments, idealistically all possess qualifications and competences that are disciplinary, and; qualifications and competences that are of a more professional managerial character, for instance in the form of managerial experience attained outside the universities. However, there is a clear tendency in the interviews towards the attitude that qualifications and competences of a more managerial-professional character, is viewed as more relevant at the levels of headmasters and deans, than it is with regard to the management at the level of departments: As a central area of responsibility and competence in relation to the administrative management situated at the level of results, possession of disciplinary qualifications and competences is emphasized by a vast majority of the interviewees as crucial for obtaining of managerial legitimacy; and thus for the successful implementation of ideas and initiatives from the heads of departments, on the level of operational management. The significance of disciplinary qualifications and competences in relation to this intermediate level of management is an essential part of the explanation why a majority of the interviewees declare, that the departmental management ought also in the future to be recruited from within the scientific staff at that department.

The departments constitute the level of research execution at the universities, and it is emphasized in the interviews, that the form of research management carried out by the head of department here, is distinct from the kind of research management carried out by the Headmaster and the deans, because it is here, at the level of department, that the immediate contact between the administrative management and the scientific staff, i.e. the operational management at the level of results, takes place. It is thus emphasized by many of the interviewees, that an intimate relationship exists, between the tasks assigned to the heads of departments of a more administrative character, and the tasks also carried out by the heads of departments in relation to decision making of a more operational character, concerning the quality of the work pursued at the level of results.

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[31] It should be noted here, that one of the questions qualitatively pursued in all interviews were, whether the development contracts should be viewed as expression of a higher degree of ministerial control, or rather as a means for more autonomy.

[32] “Professionalism” referring to managerial-professional experience and competence; and “disciplinarity” referring to academic and scientific merits and qualifications. It should be noted in context to an anthropological perspective on knowledge that are tradition-specific, that a multitude of traditions of knowledge and sub-traditions could be identified within the university staff. This has not been the object of this project.

Candidates for the post as head of department can in principle have acquired relevant qualifications and competences through experience from other places than internally at the department itself. When a number of the interviewees still prefer the heads of departments to be recruited from within the scientific staff at that department, the explanation for this is that the staff at the department will probably, to a higher degree, trust a manager that originates from that department, is loyal towards that department and who knows the discussions that run there as well as the culture that exists at that department. In other words, according to the viewpoints presented here; not only does it require disciplinary qualifications and competences to achieve managerial legitimacy at the level of departments, but a high degree of sensibility in relation the processes that take place at the department is also required, as is the capacity to get on in an often vulnerable and unique research environment. Several of the interviewees, in relation to this, remark that it will lead to problems, and in the worst case will have a destructive effect on the research-environments if the heads of departments do not enjoy the trust of the scientific staff, and thereby be capable of achieving legitimacy, in relation to the managerial decision-making at the department.

One of the problems that are emphasized, in relation to the democratic mode of appointment and recruitment, is that the extent of managerial tasks assigned to the heads of departments is so extensive, that the position as head of department is not something one takes on with a great deal of pleasure, if one is a very active researcher. Thus there might be rather strong incitements for the occurrence of a situation in which it is not necessarily those researchers with most disciplinary insight and experience that are elected heads of departments. One of the suggestions that have been put forward by the interviewees, in relation to this problem, is the possibility to offer the heads of departments a stronger degree of administrative backup.

Part of the explanation for the relatively higher degree of openness towards managers at the level of Headmaster, and the deans that possess qualifications and competences of a more managerial-professional character is, that the managerial tasks that managers at these levels of management is expected to take care of, is described by the interviewees as being of a more overall administrative, political and outwardly kind and character. The managerial tasks that the Headmaster and deans carry out in relation to cultivation of external relations towards for example the politicians, industry and the public in general, might with advantage be taken care of by managers with more managerial-professional qualifications and competences.

Another part of the explanation for the relatively higher degree of openness towards managers at the level of Headmaster and the deans that possess qualifications and competences of a more managerial-professional character, is related to a general expectation among the interviewees, that managers with this type of qualifications and competences, that are appointed and recruited on a limited tenure, to a higher degree will have a legitimizing effect in relation to the external partners. Thus the higher degree of openness towards managers at the level of the Headmaster and the deans that possess qualifications and competences of a more managerial-professional character, should maybe be viewed not as much as a criticism of the elected headmasters and deans, but as an expression of a general perception expressed by the interviewees, of a markedly lack of trust among the political managers towards the administrative and operational levels of research management at the universities.

This part of the interview material has sought to focus on the complexity that characterizes many of the questions and problems that are raised in the debate anticipating the 2002 management reform of the universities. This part of the project demonstrates a high degree of uncertainty in this debate, as well as a distinct muddiness regarding nuances and levels of research management, in relation to the questions and problems that are discussed. This situation is not an optimum point of departure for constructive discussion of the management and future of the universities; and it does not appear suitable in relation to the advancement of a relation of trust between the actors and communities of interest involved in the process of research management and research policy.

Summary of the implications of the study in a wider theoretical context

One thing that catches the eye in the reading of the empirical material, is the difference between the knowledge and keywords that are communicated, presented and represented, and clusters of keywords that are formed in the text analysis and in the interview analysis respectively. The attitudes put forward towards the development contracts and the proposals anticipating the 2002 management reform in the text-analysis are generally of a much more one-sided positive or critical character, than those attitudes put forward in the interview material, that are generally more sensitive with respect to the nuances and complexity of the questions and problems discussed. Thus, the debates under investigation in the text-analysis generally present themselves as being characterized by a higher degree of dualism and dichotomization, than is the case with the interviews carried out with representatives from the research management at the universities. The question of science and its role in society thus seems not only to be underlying the public debate concerning research management, research policy, development contracts and the 2002 management reform; the two (opposed ideal-type) perspectives on science and its role in society described on page 4-5 also seem, at least partly, to guide present presentations of perspectives on the questions and problems discussed in the public debate.

Another thing that seems evident from the reading of the empirical material is a marked lack of substantial announcements, not the least from the side of the politicians in charge, as well as an environment of considerable insecurity and mistrust among many of the actors and communities identified in the text-analysis.

These circumstances; the relatively high degree of dualistic thinking and dichotomization in the public debate, the lack of substantial announcement regarding the political initiatives under investigation, and the apparent environment of insecurity and mistrust is interrelated. These circumstances all participate in rendering the complexity of questions related to the question of research management and research policy obscure. Further more: The widespread use of keywords, especially in the text-analysis, should be recognized as a factor that contributes to create confusion, not the least with regard to the positioning of standpoints of actors and communities of interest, in relation to the questions and problems discussed in the empirical material.

The list of keywords found in the text-analysis is extensive: “Quality”, “efficiency”, “freedom”, “independence”, “disciplinarity”, “production”, “market”, “productivity”, “responsibility”, “accountability”, “decentralization”, “empowerment”, “flexibility”, “transparency”, “evaluation”, “measurements”, “competition”, “commercialization”, “stake-holder”, “utility” and even “exploitation”, are all keywords used more or less energetically by both supporters and opponents of the political initiatives discussed. Though different actors and communities of interest do, to a large extent, make use of many of the same keywords, obviously the meaning invested in these by different actors and communities of interest are not the same.

One illustration of this is the way in which the development contracts have been presented by the ministries in charge, as an offer to the universities of decentralization, more independence from the ministries and a higher degree of freedom - as if the development contracts were liberating and emancipatory. According to the ministries in charge, the assumptions underlying this offer is that this will; *“[…] raise the level of ambition in the universities, stimulate their inventiveness, and increase productivity and quality in the core-areas*” (Forskningsministeriet, 1998; p 7.*Own translation*). Though it is noted by the ministries that the gains they themselves expect, presuppose *“a voluntary and motivated participation”* from the side of the universities, and that the universities are indeed not bound to enter into development contracts. It is, at the same time, also emphasized, that these will be a precondition for the possibility of the particular institution to; *“[…] arrange themselves according to their own individual situation, and seek their objectives realized through outwardly co-operation”* (Ibid. pp. 7-8).

From the side of the critics though, the development contracts are viewed rather differently: As a manoeuvre intended to gain more political influence on, and control of the universities and the activities pursued here.

The critics thus tend to view the establishment of the development contracts as not that voluntary, and certainly more an expression of a process of centralization of power at the political level of management, than one of decentralization of power in the form of a higher degree of political independence, or academic freedom attributed the lower levels of management in the universities. One of the concerns expressed by those that are critical towards the development contracts, is that these will lead to a decrease in the quality of the work carried out at the universities, by shifting attention from the core-competences at the universities towards the performance of tasks that are of a more secondary character, - thus making the universities less effective.

A central point in connection to the views described above is that it would be a mistake, and one that unfortunately seems to be made all to often, especially in the public debate concerning research management at the universities, to juxtapose those actors and communities of interest critical towards the idea of the development contracts and the 2002 management reform, with those actors and communities of interest that are organizationally and institutionally affiliated with the universities. Just as it would, to juxtapose those actors and communities of interest sympathetic to the establishment of development contracts or the 2002 management reform, with those that are (at least traditionally) positioned externally in relation to the universities. In other words: Critics as well as sympathizers can be found on both sides of the internal/external dichotomization.

”Disciplinarity ” appears as a central keyword in the interviews, not least in relation to the question of which qualifications and competences that should form the basis for the selection and recruitment of the managers at the administrative level of research, in relation to the proposals of the 2002 management reform. Even though ”disciplinarity” is also found in the analysis of the empirical material made up of political documents and articles published in the press; it does not appear, in this part of the empirical material, to form part of any organized, consciously formulated and communicated response to the question of what effect changes in the relationship between research management and research policy have on research and researchers. When there is a response to this problem of a more collective, conscious, organized nature, it is usually a defensive act, as a reaction to an invitation from the political level of management[33]

Another set of keywords that are also used differently in the text-analysis and in the interview-analysis respectively are those of (political or governmental-) “independence”, and (academic-) “freedom”. Both “independence” and “freedom”, are heavily represented as keywords in the text analysis, where they are being employed by both critics and sympathizers of the two political initiatives under investigation, but obviously with very different meaning. In the interview-analysis on the other hand, “independence” and “freedom” do not seem to play any significant role as central keywords.

The public debate concerning research management and research policy further more, shows how actors and communities of interest often tend to mutilate each others points of view in the process of discussion. This kind of mutilation of viewpoints, are not the least made possible by the use of keywords. Keywords in general, and particularly the keyword “quality”, display an allmost extreme degree of flexibility regarding the range of significance, meaning, and ideas that are invested into them, making them almost perfect vehicles for the mutilation of the viewpoints of *other* actors and communities of interest.

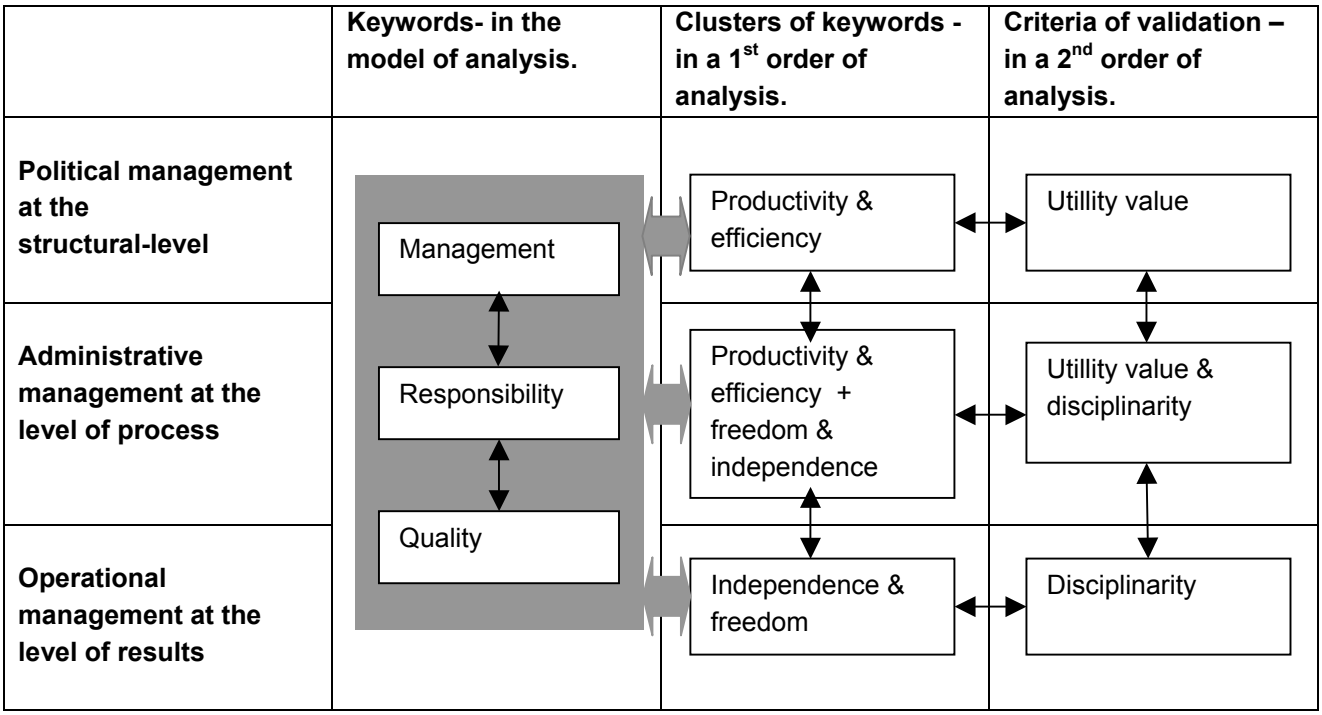
It should be clear by now, how the use of keywords in the debate [34] blurs discussions of the development contracts for the universities and the 2002 management reform, at least at an immediate level of analysis of the knowledge being represented and communicated by the range of differently positioned actors and communities of interest. It seems fertile thus, to move up the analysis to a higher degree of abstraction in order to create a theoretical model against the background of the empirical material. Moving towards this 2nd

[33] Though hundreds of hours were spent at the universities, formulating ideas and suggestions as a response to a hearing about the proposals put forward by the ministries in charge, in connection to the 2002 management reform, this only had a minor effect on the final wording of the 2003 university law, as demonstrated by a comparison presented on the homepage of The Danish Headmasters Conference; http://www.rks.dk/sider/tema_debat/nyunilov/fra_udkast_til_lov.pdf).

[34] As described on pp. 65-66.

order of analysis thus naturally entails a higher degree of interpretation, than is the case with the more descriptive character of the 1st order of analysis. The model presented below is an attempt to do exactly this.

The reader is encouraged to regard the model as suggestive and illustrative, rather than definitive in any exclusive way, all concepts presented in the columns could thus obviously be labeled keywords. The model shows, in a stylized and condensed form, the expectations that, in a perspective of mediation, meet the research management positioned at the level of process, from the political management and the operational management; not necessarily as they are expressed at the levels of management analysed, but as they are described in the empirical material by the variety of actors and communities of interest that seek influence on the political agenda.



Having discussed some of the ways keywords are used differently by different actors and communities of interest in the different parts of the empirical material, and having attempted to set up a model of how these relate to the clusters of keywords that are formed and the criteria of validation that is (or should be) employed at the three levels management in the model of analysis, we will turn our attention to the findings of the research-project in a knowledge perspective. The central question here is what changes the development contracts and the 2002 management reform have lead to, in relation to the three faces of knowledge: The substantial corpus of assertions, a range of media of representation, and a social organization.

The establishment of development contracts for the universities clearly is a new media of communication and representation employed in the relation between university research management and national research policy. The 2002 university act as a political document that later passed into legislation as the 2003 university law, has also been employed as a media of communication; and unlike the development contracts that only have a semi-legal political status, the 2003 university law is obviously a juridically binding document. Both of these media of communication have been implemented on initiative from the political management.

Besides the development contracts and the 2002 management reform, also evaluations, benchmarking, citation-indexes and the counting of publications are medias of communication found in the relationship between the three levels of management discussed here, and all of the medias of communication need to be

viewed in the context of each other, as parts of the system of accountability and audit that characterizes the interplay between research management and research policy.

Also with regard to changes in social organization at the universities, the results of the research-project presented here suggest that the development contracts and the 2002 management reform have an impact on the social organization(s) at the universities.

One aspect of how the development contracts have lead to changes in the social organization is the way in which “accountability” and “responsibility” have come to play a more significant role in the relationship between research management and research policy. Both “accountability” and “responsibility” are two-dimensional in the sense that there is always *someone* and *something* to be “accountable” and/or “responsible” towards. The establishment of the development contracts thus emphasizes that the “accountability” and “responsibility” of the administrative management refer to the political management at the structural-level, rather than down the management-hierarchy, towards the operational management at the level of results. This clearly indicate a strengthening of the political management, that now has gained more direct influence on the formulation of the objectives of the universities, and thus also on the criteria of validation employed in the rising regime of audit-technologies and accountability.

The 2002 management reform that anticipated the 2003 university act, clearly has also lead to changes in the social organization at the universities, since these have opened up the research management at the universities for interested parties that were formerly considered external, to such a degree that these now constitute the majority of the newly established boards, that now stand as the highest authority at the universities, next to the ministers in charge. Before the 2002 management reform, representatives from the students and staff made up the majority in the governing councils at the universities. The new law in this way settles with the collegial self-government. This obviously indicates a strengthening of what has traditionally been characterized as external or societal interests - now being imported into the midst of the universities.

The 2002 management also indicates a centralization of power at each level of management that in combination constitutes the administrative level of management in the form of the headmaster, the deans and the heads of departments. Whereas the administrative management situated at the level of process were formerly chosen by democratic election by and from the academic staff, with students participating in elections at the level of Headmaster and deans, The Headmaster that are now appointed by the newly established boards, employ the deans, who then employ the heads of department. In this process, the collegial councils at each of these levels within the level of administrative management, that previously possessed the final competence of decisions, have been replaced by advisory organs that the managers may have a duty to listen to; but whose advise they can finally choose to ignore.

The findings of the research project, with regard to changes in social organization at the universities, suggest that both the establishment of development contracts and the 2002 management reform of the universities, participated in a process of empowerment at both the political and the administrative level of management; and in that process, the political management managed to; change the criteria of validation for the recruitment of the research management; gain further influence on the objectives of the universities, researchers and research, and; install a new superior level of management into the administrative management at the level of process, in the form of the newly established “university-boards”.

The process of empowerment at the political and the administrative levels of management suggested in the analysis, clearly indicate the occurrence of a parallel process of disempowerment at the operational level of management.

To what degree has the establishment of development contracts and the 2002 management reform (2003 university act) then lead to changes with regard to the face of knowledge which Barth (2002) labeled, the substantial corpus of assertions. The exact extend to which changes have occurred within this analytical

category is obviously hard to define, but that changes have in fact also occurred in the substantial corpus of knowledge found at the universities seems evident from the changes identified with regard to the range of medias of communication and representation that are employed, and changes in the social organization(s) of the relation between the research management situated at the different levels of management. The three faces of knowledge discussed here, according to Bart[35] are interconnected, even mutually determining.

Changes in the substantial corpus of assertions is also indicated in the empirical material, in the analysis of the ways in which keywords are used and clusters of keywords formed, in the process of policy making, and by the informants in the interview analysis, referring to the "consciousness-raising" significance of the development contracts at the universities[36].

One of the central questions concerning the changes identified with regard to the three faces of knowledge discussed above, is whether the rise of new public management in the form of development contracts for the universities and the 2002 management reform, has resulted in the establishment of new norms and practices. This certainly seems to be the case, at least with regard to norms and practices related to management and governance at the universities. The kind of political governance of the universities that are analyzed in this research project certainly seems to be in accordance with an apparent all most ubiquitous consensus about aims, objectives and procedures that are also identified in British higher education. There are many differences between Danish and British higher education, but that there is culture on the make here, according to Marilyn Strathern, is evident from the concomitant emergence, and dominance, of what are deemed acceptable forms of social and ethical practices, that will convince and persuade those to whom accountability is to be rendered (Strathern, M. ed. 2000: pp.1-2).

Whether the processes of change identified with regard to research management and research policy, the establishment of development contracts for the universities, and the implementation of the 2003 management reform, has also participated in changing norms and practices in relation to research and researchers, might be too early to determine yet, since the political initiatives analyzed in this research-project have only recently been implemented at the universities. Changes in the norms and practices related to research and researchers at the universities, have been indicated by a couple of actors participating in the public debate concerning research management processes in the context of changing research policies, analyzed in the text-analysis. Political journalist Lars Mogensen thus argues, that the establishment of development contracts participate in forcing the universities to a reorientation of their research-activities, in such a way that these to a higher degree incorporate commercial objectives (Mogensen, L. 1998). Also Stefan Hermann, associate external professor at the university of Aarhus, argues that researchers as well as managers at the universities is taking over the social norms of business communities, emphasizing the utility value of research (Thorup, M. L. 1999).

The reading of the empirical and theoretical material in a knowledge perspective thus also, as it was the case with regard to the findings of the analysis regarding the use and abuse of keywords, support a view on the interplay under investigation in the analysis of research management in the context of research policy, as being characterized by an asymmetrical balance of communication and flow of power between the parties involved: The politicians in charge being in the offensive, and the limited number of representatives from the staff at the universities that speak up, in the defensive.

The administrative management, according the model of analysis applied in this research project, is faced with the task of mediation between the political management at the structural level and the operational management situated at the level of results, the ability to do so successfully is according to the findings of the interview material, an obvious area of responsibility and competence related to research management processes at the level of process. In order for the administrative management to successfully mediate between the criteria of validation related to the areas of responsibility and competence at the two other levels

[35] See page 66.
[36] See page 73.

of management, it seems evident that also knowledge from the operational management at the level of results, should be recognized as a valuable source of information in the process of policy-making with regard to the possibilities and constraints of research management initiatives at the universities.

The argument put forward in the analysis is, that in the ideal-models presented here, it is part of the competence and area of responsibility of the management at the operational level to engage into discussion about the quality of science – and that it is part of competence and area of responsibility of the management situated at the other levels of management, to be sympathetic and sensitive towards this sector of knowledge. Research management are in itself considered a means with which to achieve other objectives, such as the creation of the political and economic framework for the universities, that of mediating between knowledge and ideas from above as well as from below in the management hierarchy, creating the best possible framework for the process of scientific creation/production, that take place at the level of results, where the operational management create/produce academic knowledge. Obviously different criteria of validation are employed and sustained at each of these levels of research management, but all actors and communities of interest agree on the importance of science in modern society, and thus share (at least idealistically), a common objective in the creation/production of academic knowledge.

The reading of the empirical material indicates an asymmetrical balance of communication and flow of power between the parties involved, in which the political management seems to a large degree to define the majority of the keywords and concepts in the hegemonic discourse regarding research management in the context of research policy: And in this process, the political management seems to have more or less succeeded in holding especially the administrative management in a grip that resembles the situation described by Bourdieu´s use of the concept of *doxa*, referring to *"when there is a quasi-perfect correspondence between the objective order and the subjective principles of organization (as in ancient societies) the natural and social world appears as self-evident"* (Bourdieu, P. 1977: 164). What is the explanation for how the political management has seemingly succeeded in silencing the management situated at the lower levels of the management hierarchy?

The politicians are moving fast and often change the criteria of validation. The text analysis thus showed that, already before the negations regarding the establishment of the development contracts were in place, discussions anticipating the 2002 management reform and 2003 university act had begun. Also discussions concerning the 2002 management reform were characterized by a lack of substantial announcements. The announcements that were put forward by the political management more often than not came in large opaque bundles of proposals and ideas, wrapped up in political-rhetoric and clusters of keywords.

Another explanation for the fact that the operational management does not seem to engage more actively in the process of policy making, which has also been pointed out in the interview material, is that it is considered part of the area of responsibility and competence of the administrative management, to release the operational management from to much of the administrative work. The formulation of response from the operational management, regarding the affect of the political initiatives discussed here on academic knowledge, though, should not be confused with the administrative tasks assigned the research management at the universities.

Also as noted by Marilyn Strathern, audit technologies and accountability as political means are in reality almost impossible to criticize since they apparently advance values that the researchers also advance themselves, such as responsibility, transparency regarding results and the expansion of access to these (Strathern 2000:3).

One way of criticizing audit technologies and accountability as political means, though, is through a self-reflexive perspective on the ways in which new political initiatives and procedures, influence research within particular disciplines at the universities.

The operational management who is responsible for the "quality" of work at the level of results, in accordance to the model of analysis applied in the analysis presented here, is the best suited persons to speak up, when it comes to the question of how the new forms of management introduced in the universities, affect themselves and their research, that is; the possibilities and constrains that the mode of management carried out on the structural level and at the level of process have, for the "quality" of their work, in an optic on the specific criteria of validation that are produced and reproduced within particular traditions of academic knowledge. According to the model of analysis applied here, it should also be recognized as part of the area of responsibility and competence to do so, especially when the degree of changes in the research management processes and the level of pressure are as extensive as indicated by the analysis presented here.

As Barth points out: *"Even if our [the universities] only function were to produce graduates for employers outside the academic sector, the conditions under which we do so are unique in that the university sector must be capable of reproducing itself or it disappears. Unlike all other modern institutions, we have no other place to turn for skilled recruits in the hundreds of different disciplines: unless the university sector is allowed to produce full-fledged scholars, it will not be there to serve any of its other functions in 20 years´ time"* (Barth 2002: 17).

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Chapter 3: Research environments

3.1. Dynamic Research Environments - A Development Model

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Abstract: The article outlines a model for the development of dynamic and innovative research environments in national innovation systems. The development model is based on an in-depth study and analysis of 15 research environments selected by the Danish Council for Research Policy as examples of dynamic and innovative public research environments. According to the model, research environments follow some stages with respect to epistemological, organisational, and socio-cultural development that either enable them to advance from one stage to the next in the model or impede this advancement. The consequence of the latter is either a static state or dissolution. In the long run only dynamic and innovative research environments survive. The analysis of the studied cases identifies several preconditions that have to be present in such research environments in order for them to emerge, develop, and finally reach excellence. The results presented here may well be a valid tool for policymakers, particularly in Europe where the framework conditions for public R&D are comparable to the Danish.

1. Introduction

Research, development, and other innovation have been put forward as a top priority together with upgraded human resources in the development of knowledge-based economies. The aim in the European Union to build the European Research Area (ERA) in an efficient way has created a need for knowledge on how research environments work and which research environments that can be used as examples of best practice in a development process towards a well-functioning and efficient ERA. The present paper is based on an in-depth study and analysis of 15 research environments selected by the Danish Council for Research Policy as examples of dynamic and innovative public research environments, c.f. Graversen et al. (2002b).

The analysis identifies a number of common characteristics among these research environments, c.f. Graversen et al. (2002b). Together with the historical path of each research environments these characteristics has been used to identify a general development model of research environments. Lastly, the selected research environments has been used to identify the unique preconditions that make these well functioning and efficient research environments dynamic and innovative.[37] The preconditions have to be present in order to develop dynamic and innovative research environments further into centres of excellence.

Other aspects of dynamic and innovative research environments are discussed in Graversen et al. (2002a) and in Kalpazidou Schmidt et al. (2003) regarding research policy perspectives as well as in Kalpazidou Schmidt (2002) and Langberg (2003) regarding organisation and management in dynamic and innovative research environments.[38] Identification of the most effective and efficient framework conditions supporting existing and new public research environments becomes ever more important for policymakers in an attempt

[37] Naturally, some of the common characteristics also end up as preconditions, e.g. openness, strategic planning, research competent management, or highly motivated researchers.

[38] See also Ziman (1994), Benner and Sandström (2000), Becher (1989) and Clark (1987) among others as general references on these aspects of research environments.

to create and maintain the necessary structures that secure a sufficient degree of research excellence in the national as well as in the European innovation system.[39]

Even though research policy initiatives may facilitate the creation and maintenance of new research environments, the initiatives and ideas have to emerge from existing resources in the innovation system, e.g. the existing researchers or research environments. Hence, the emergence, management, organisation, and development of research environments are as vital as the political and economical infrastructure surrounding it. The one part requires the other in order for the interaction to give optimal results for the knowledge-based economies.

1.1. Centres of Excellence

Recent policy initiatives have focused on the emergence of Centres of Excellence as a way to reach the research aim of a European Research Area, c.f. European Commission (2000). Centres of Excellence are defined in the present paper as research environments that produce research of the highest international quality.

Improving the quality of research centres is seen as the main factor in developing the ERA. While this is clearly important, the present analysis identifies dynamism in the entire innovation system that fosters the steady and continuous development of promising new research area into centres of excellence. Whether this potential is materialised as centres of excellence capable of producing research of the highest quality depends on the structural framework and the ability to adapt to changes.

The construction of a well functioning ERA depends highly on the national frameworks and structures for research, external funding possibilities, and also on internal factors in the research environment such as skilful research management, visionary managers and creative researchers. Hence, the bottom-up emergence of research environments requires sufficient structural external support in order for them to develop to centres of excellence. Narrowly targeted national research programmes may result in centres of excellence in the targeted areas, but this may nevertheless be less efficient and may have smaller societal impact in the long run. In stead, better broad structural conditions for these and other areas will benefit in the emergence of (more) centres of excellence in several areas, including the targeted, to the benefit of the entire national innovation system. Better knowledge concerning the best suitable research policy that enables these structures to be present is a first step towards an innovations system with centres of excellence, c.f. Koch et al. (2003).

This article presents the case examples of dynamic and innovative research environments in section 2.1 and uses these to identify common stages in a general development model for research environments in section 2.2. Section 3 outlines the common characteristics of the selected research environments that are attributed to both internal and external factors in the environments as well as interactions of these. Furthermore, the characteristics are related to the concept of rural and urban research environments developed by Kalpazidou Schmidt (1996). The studied cases show characteristics of the urban research environments. Section 4 summarises the common characteristics and the necessary preconditions for excellence in research environment. The preconditions for development of research environments to centres of excellence concern organisation and leadership, framework and structures, and resource allocation. Section 5 concludes the paper.

[39] The national or regional politicians may be more oriented to create framework structures that support local based R&D and secure that it stays local. Hence, a European synergy effect may emerge if the regional policy making becomes more coordinated and interacted with the ERA research objectives.

2. Emergence and development of research environments

Open-minded yet focused on ideas that require full attention and epistemological research can best describe developing research environments, c.f. Graversen et al. (2002a). Allowing new ideas to emerge, networking and exchanging of ideas with other environments and internal and external cooperation secures that research environments develop over time giving the basis for the achievement of excellence in research. The analysis of the studied research environments provided a number of benchmarks for dynamic and innovative research environments. These benchmarks and other common characteristics were used in the analysis to identify a common model for the development of research environments. The model has as a point of departure the origin of research environments and follows different stages of development to centres of excellence. The model is general enough to apply to all types of research environments.

According to the model, closed and static research environments will only develop slowly and be less dynamic than other research environments. In the medium to long run they will be less innovative and cease to exist due to lack of funding in an innovation system based on funding competition.[40] Hence, without renewal and development of ideas and knowledge, such research environments will degenerate and disappear over time.

2.1. Case examples of dynamic and innovative research environments

The empirical cases that make up the data material were collected and used in a study by the Danish Institute for Studies in Research and Research Policy (AFSK) in autumn, 2001. On initiation by the Danish Council for Research Policy, AFSK analysed the cases and presented a series of structural and process related conclusions regarding common characteristics of dynamic and innovative research environments, c.f. Graversen et al. (2002a). The Danish Council for Research Policy has chosen the empirical cases based on advisory work in connection with the activities of the Danish Research Councils.

The studied research environments represent all fields of science and physical or non-physical institutional frameworks. The cases represent various administrative and organisational types of research environments, such as university departments, governmental research institutions, research centres, or departments of existing research environments. The cases consist of newly established as well as old well-established research environments. The research environments have between five and 200 researchers employed or affiliated and their existence varies between one and 15 years in the present organisational form. However, a few of the research environments have been active in different organisational structures for more than 40 years.

The research environments have typically been created as a consequence of the development of a new idea, a new theme or the renewal of an existing field. However, the research environments are not identical regarding age, size, organisation, structural form, frame or origin. Despite the differences, the analysis identifies a common structure in their development over time. Some common initial conditions have been present to secure the spin off of the research environments and other internal and external conditions have been present to secure their survival and development over time towards centres of excellence, c.f. section 2.2.

The analysis of the 15 research environments reveals some common characteristics for dynamic and innovative research environments. These characteristics concern the emergence, management, organisation, funding, and development of the research environments. A summary of these features is outlined in table 1 in section 4. The main conclusion is that dynamic and innovative research environments

[40] The policy trend in Denmark as well as in the ERA goes in the direction of higher funding competition among the research environments. Among the criteria for future funding that are becoming increasingly important are societal relevance, industry-science cooperation and external co-funding rates.

clearly have a common point of departure, use strategic planning, and have well-defined goals but also that they fundamentally rely on a solid and acknowledged research base.

2.2. A development model of research environments

The findings in the analysis were used to identify groups of research environments with a significant amount of common characteristics that could be used to gather them into common clusters. Furthermore, the clusters of research environments could, after a more detailed analysis, be linked in a unique model for research environments where the groups were fitted into different time development stages. The clusters fit in at the upper stages in the model that show how research environments emerge, develop, become dynamic and innovative and not least when they perform excellent research, c.f. tables 1and 2.[41]

The identified development model will be outlined in the following. As the discussion will underline, the model can be seen as a general development model for research environments. This means that the development model is general enough to fit many different kinds of research environments, i.e. also research environments not included among the empirical cases and independent of whether they are dynamic, innovative or neither of these. All the studied innovative and dynamic research environments fit in at the upper stages in the model where they all have passed the stages below and have qualified to be judged as dynamic and innovative, c.f. tables 1 and 2.

2.2.1. A development model

Table 1 illustrates the stages in a general representative research environment's development towards excellence. The common features in the development among the 15 studied research environments have given the basis for a model for how and at what speed research environments emerge, develop, change, and reorganise in a continuous dynamic process. The time dimension may vary for each research environment, meaning that the stages are passed faster or slower for some research environments than for others.

The model follows a development track starting at stage one and continuing up to the excellence stage as illustrated in table 1. The historical path of the studied research environments has been used to identify the lower stages in the development model. The dynamic and innovative research environments have all been through these earlier stages. At all the stages the research environments have been further developed based on a high quality research fundation. A clear and visible focus on research productivity, research quality, and competence development characterise the dynamic and innovative research environments on all the stages in their development. However, this may not in general be the case for research environments at the earlier stages in the model. If it is not the case, these latter research environments will at a lower stage in the model cease to develop and become static or close down.

At the first **initial stage** in the model, the "material" that makes or initiates the emergence of the research environments is found; c.f. table 1 and table 2. These original initiators may be in the form of external pressure on existing research environments, for example a university department or an institute that is threatened by closing due to poor research production, organisation or management problems. Another initiator is fiery souls, who through an enormous engagement and high research capability establish the basis for a new research area. These initiators may typically through external funding over time establish an informal research group or centre. Yet another initiator is found in transdisciplinarity, i.e. parts of existing research fields that become self-standing disciplines. Related research environments may become so visible that it seems natural to establish a group based on existing transdisciplinay networks, like for example nano-science in recent years. Common for the different initiators is a visionary research based plan for the next move to the **planning stage** in the development model.

[41] There were natural dissimilarities between the research environments; dissimilarities that were specifically related to scientific field, policy or person dependent circumstances that do not contribute to the common characteristics and the general development model.

The vision or visionary plan for a research environment typically requires the existence of an informal group or network consisting of like-minded researchers before it can continue. On the **1st generation** stage there often is a very visible natural leader, who by engagement, expert knowledge, reputation and/or management abilities secures that the environment as well becomes visible, gets financial support, and gathers the necessary research expertise. Having these aspects present allows the informal group to perform research output supporting its existence and further development towards the **2nd generation** stage where they become a formal and established research group, centre or unit. It is first at this stage that the research environments are recognised as real and formal research environments that can be referred to as such.

Table 1. A development model for research environments

Development stage	Characteristics of each stage
Initial stage	External pressure / Fiery soul(s) / Critical mass
↓	↘ ↓ ↙
Planning	Vision or plan is implemented
↓	↓
1st generation	Informal group or network is built
↓	↓
2nd generation	Research environment is formally established
↓	↓
3rd generation	Reorganise to meet change in conditions
↓ ↑	↓ ↑
Consolidation	Excellent research output Specialise and consolidate
↓ ↑	↓ ↑
4th generation	Consolidate Excellence Reorganise to meet changes in conditions Become Centres of Excellence

Note: The arrows illustrate the research environments' development possibilities between the stages. This implies that they can either advance to the next stage or decline. See also table 2.

After the formal establishment as a 2nd generation research environment it is the reorganisation of the research environment and consolidation of the research quality and production that becomes the most important issue for the medium to long run survival of the environment. Typically, the first reorganisation of the research environment is the most difficult including the largest risk of failure. A research environment that has passed its first major reorganisation has moved over to be a **3rd generation** research environment. The reorganisation at this point in order to be a 3rd generation environment often implies an academic or structural reorganisation to new or changed internal as well as external conditions such as professional, epistemological, economical or structural changes. At this stage it may become clear that the initial and original manager or research leader that started the process might have been a skilful developer but not a similar good consolidator or research administrator. In such cases the first reorganisation also requires a shift of manager, management style or research strategy.

Given that the research environment survives the establishment phases and the first reorganisation, their next hurdle to overcome is to reach the top academic level where they produce excellent research in a continuous steady flow. This **consolidation** stage includes organisational focus on objectives such as

renewal, innovation, reorganisation, and excellent research outcomes that match the scientific purpose. Passing the consolidation stage with success characterises the **4th generation** research environment meaning that the initial stage vision to create an excellent research environment in the field has succeeded, although usually in a reformed version. For the research environments, the challenge becomes to remain at the top or keep their position as **centres of excellence** in the field through a continuous epistemological, organisational, and socio-cultural development of the research environment in order to adapt the organisation to internal as well as external changes.

Table 2. The dynamism at each stage in the development of research environments towards the level of excellence

Stage	Dynamism at each stage
Initial stage	Either an external pressure, a fiery soul or a critical mass of researchers initiates the start for the creation of a research environment
↓	The vision or plan circulates in the existing research system
Planning	The vision or plan gets support from a group, the management or an internal or external financial source
↓	The vision or plan gathers an official group of researchers around a common research area or subject
1st generation	The research group focuses on a specific research field and uses eventual financial support to form the group of researchers and research expertise
↓	The research group strengthens their standing through quality research that can justify support for creation of a formal research group
2nd generation	The research group is reshaped as a research environment such as a centre, a department or a research unit
↓	The research environment strengthens professionally and organisationally. The original research objectives develop further and become the basis for the environment
3rd generation	The research environment is reorganised based on the original research aims and focuses on dynamism and innovation
↓ ↑	The research environment raises the research quality to excellence levels
Consolidation	The research environment performs excellence research on an international level because it has succeeded in renewing, developing, and consolidating their research in a dynamic organisation
↓ ↑	The excellent research quality is retained by a dynamic and innovative research environment
4th generation	The research environment produces excellence. It is reorganised, renewed, and developed in a continuous process where the aim is to retain and support the excellent position in the international research system

Note: The arrows illustrate the research environments' development possibilities between the stages. This implies that they can either advance to the next stage or decline. See also table 1.

Passing some stages does not ensure that a research environment will finally reach an excellence level or remain at such a level, i.e. become a 4th generation research environment as shown in tables 1 and 2. At the same time it cannot be taken as given that a research environment will remain at the excellence level once it has reached it. According to the model, research environments exist on a given stage as long as it is legitimated by research quality, research policymaking or funding. Along the common development track research environments emerge, develop, and consolidate or fail to do so over time by various reasons.

Research environments not fulfilling the requirement to climb to higher stages become static or degenerate and disappear in the long run, i.e. close or dissolve. Consequently, research environments can in any stage be closed if they cannot respond to the internal or external requirements.[42] If the research environments fail on any of the first five stages they disappear in their present form. They may continue in form of some other constellation, but in such a case this is a new research environment starting up again at the initial stage, or they can be transformed to a teaching unit conveying knowledge or advising, meaning that they disappear as a research environment. At the consolidation and 4th generation stage the research environments can periodically step backwards in their development, lowering the ambitions and/or research quality and/or outcome. The double arrows between the three upper stages in the model mark this option. This means that a research environment can fail with regard to research excellence in a period and fall a stage or two in the development model but continue to exist (at the 3rd generation or consolidating stage) and regain the excellence 4th generation stage after a period or fail at the 3rd generation stage and close down as an independent research unit and disappear. Hence, the terms 4th and 3rd generation mark a development stage and not an age dependent stage.

However, most research environments are not static but continuously developing and reorganising units that exist as long as their research and common internal and external interests justify it. In cases with large changes where part of the original research environment better fits into a new unit at or below the 2nd generation stage, a new research environment may emerge as a spin-off from an existing environment. It is important in this context to keep in mind that the stages are relative to the units meaning that some research environments can remain at a certain stage for a (very) long period while others pass it fast and smoothly, almost as jumping over the stage.

2.2.2. The studied research environments

The 15 research environments in the case study can all be placed at one of the upper stages in the development model scheduled in table 1. They have all survived the first critical stages and their historical development track illustrates that research environments that reach the 2nd generation stage with the formal group creation, considerable increase their further survival probability. The research environments in the case study are all well-established environments that work on justifying their existence through reorganisation, research consolidation, development, and innovation in order to secure their position in the Danish (and global) innovation system.[43]

Two groups of research environments are in their first organisation or reorganisation stage trying to match the actual research framework and conditions and developing the quality of their outcome. Another group of research environments have passed this stage and are consolidating their research position as a dynamic research environment in the national innovation system. Lastly, a third group of research environments out of the 15 studied research environments can actually be characterised as 4th generation research environments. They have a stable and solid production of excellent research and are already centres of excellence.

[42] The model can also be seen as a general survival model of research environments where the generality in the model is secured through a closing possibility at each of the lower stages.

[43] The placement of the research environments on the upper stages in the model is based on the analysis of the research environments' performance and historical evolution together with the written material from the Danish Research Councils and the Danish Council for Research Policy.

3. Characteristics of dynamic and innovative research environments related to a theoretical framework

An in-depth analysis of the case examples of dynamic and innovative research environments revealed a number of common characteristics of these research environments, c.f. Graversen et al. (2002b). Firstly, the characteristics were identified as internal and external to the environments factors, c.f. table 3 and secondly, compared to definition of factors characterising rural and urban research environments, c.f. Kalpazidou Schmidt (1996).

A theoretical framework that differentiates internal and external factors or framework conditions for research environments is based on two perspectives in the literature, i.e. the "internalist" and "externalist".[44] According to the internalist perspective, internal to the environments factors such as leadership, researchers, and epistemological issues within the research environment solely determine the research environments' dynamics. In the externalist perspective these determinants are influenced by external factors as well. These external factors are for example the research policy influencing research framework or research infrastructure and also determinants based on human capital investments, organisational structure etc.

However, these latter determinants can indirectly be included in the broader research framework conditions. As also concluded in Kalpazidou Schmidt et al. (2003) the two perspectives are best seen as complementary as the empirical analysis of the influence of research policy also confirms. As a consequence Kalpazidou Schmidt (1996) developed an approach that combined the two analytical perspectives in a model for studies of research environments (MSRE), c.f. Kalpazidou Schmidt et al. (2003). The present study has as a starting point this approach that identifies the necessary preconditions for the emergence as well as development of research environments and the characteristics that result in centres of excellence that policymakers and others aim to, c.f. also the ERA proclamation.

The characteristics of the studied research environments are as mentioned above summarised in terms of internal and external factors, c.f. table 3. The characteristics will only be briefly commented here, but a general observation is that the studied research environments are very active on several areas from management over high quality research to work climate among researchers.[45] Among the internal factors identified in the research environments are factors concerning the management and leadership of research environments. Other internal factors concern the research strategy and objectives, open-mindedness for external inspiration, human resource management, and social and working climate. The external characteristics concern the frameworks that the research environment exists in. The factors are funding conditions, receptiveness with regards to external changes such as research policy initiatives, but also societal visibility, and industry-science interactions, c.f. table 3.

The studied research environments all rely on virtues like independent academic research, competence, and reputation. These virtues are successfully managed through competent leadership and the research has clear societal relevance. However, it is still important to notice that all the characteristics concerning the studied research environments are based on a foundation of research quality that is the initial precondition for all activities and development.

[44] See Kalpazidou Schmidt et al. (2003), Kalpazidou Schmidt (1996, 2002) and Foss Hansen (1988) for a comprehensive discussion of the interrelation between these two theoretical perspectives.

[45] For a comprehensive discussion of the urban and rural characteristics see Kalpazidou Schmidt (1996, 2002).

Table 3. Characteristics of dynamic and innovative research environments

Common internal characteristics
• The research environments: - Have active, transparent and research competent leadership - Are based on modern personnel management with adequate leadership qualities - Have active leaders within the research environment, in relation to the political system and to the society in general - Focus on organizational efficiency and research productivity
• The research environments have clear and visible research strategies and objectives that are mainly formulated by the management through: - Planning and coordination of activities, defining research target areas - Prioritisation among research areas and projects - Focus on research quality and competence development
• The research environments are often shaped against the backdrop of inspiration from abroad regarding: - Physical planning and organization of research - Choice of research field and subjects - Interactions through networks and other knowledge transfer media
• The research environments have a well-defined and transparent human resource management profile: - The researchers justify the managers right-to-manage in the strong research competence among the managers - Staff policies are based on the principles of research autonomy (especially during the research process) - The management profile support a scientific elite and create excellence quality - The clear recruitment policy built on core senior competences
• The research environments have a good working climate: - Based on internalised norms and research traditions - Show openness towards new ideas, methods, and traditions in an ongoing dialogue
Common external characteristics
• The research frameworks are excellent regarding: - Funding - Substantial external funding - Receptiveness to changes in research policies and academia labour market
• The research environments have flexible organisation structures: - High ability to adapt to external factors and receptiveness to structural changes - Promote own research interests in the surrounding society - Good connections to private sector and political establishment
• The research environments work in areas that have societal relevance - Combine societal demands with professional interests of the group

Source: Common characteristics summarised from Kalpazidou et al. (2003) and Graversen et al. (2002a).

The analysis of the studied research environments also revealed that such environments were primarily urban in their character, c.f. Kalpazidou Schmidt (1996) where she introduces the concept of urban versus rural research environments to describe the organisation and internal culture in research environments.[46] The overall context for **characteristics of the studied research environments and the urban research culture** can be summarised on the following four features:

- **Input**: The studied research environments have, as urban research environments, considerably larger amounts of external funding and are based on a competence that contains different generations of researchers.
- **Organisation**: The studied research environments have a hierarchical organisational structure (urban) opposed to a flat structure (rural). The studied research environments also have a considerably higher degree of research prioritisation and coordination as well as a clear research strategy.

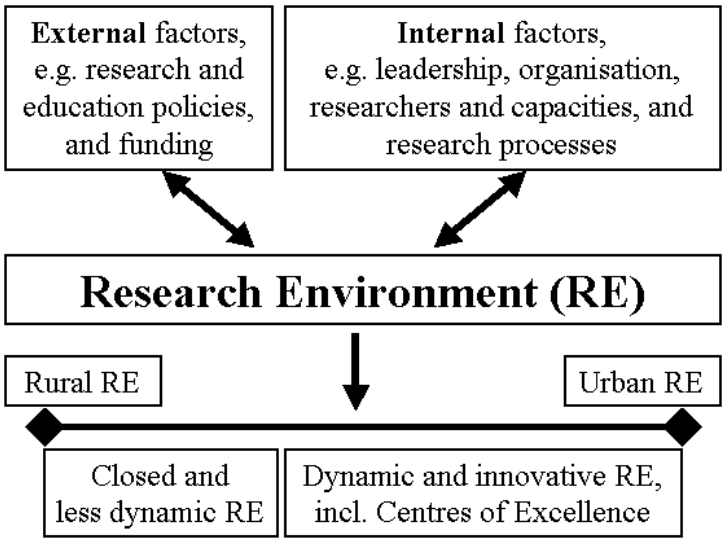
[46] The concept was used to compare the ecology, organisation and research culture of research environments to a stringent theoretical model for such items, c.f. Kalpazidou Schmidt (2002). Research environments can be placed on a continuum from having a unique rural culture to having a unique urban culture. Most research environments will be placed somewhere in between, having some characteristics from both cultures, although typically most characteristics from either the rural or urban culture, i.e. they can be uniquely categorised.

- **Research process**: Just as urban research environments, the studied research environments are based on teamwork, and have a well defined, narrow ranged, focused, and often positivistic research profile. Researchers have limited choice of areas or subjects but enjoy autonomy during research processes. The studied research environments have an intensive internal professional and social dialogue, a high external visibility, intensive networking, show high researcher mobility, and a high flexibility towards changes in external conditions.
- **Outcome**: Compared to other research environments, the studied research environments have a larger number of postgraduate students, and produce more doctoral dissertations and articles, the majority of which are internationally oriented. Moreover, production per researcher, in terms of publications, is also higher than in rural environments.

A comprehensive illustration of the ecology of the rural and urban type of research environments is given by Kalpazidou Schmidt (2002).

The interactions and links in the concepts of external and internal factors as well as urban and rural research environments are illustrated in figure 1. The external and internal factors interact with the research environment in a dynamic development and adjustment. The process and the outcome from the research environment defines whether it can be characterised as rural or urban, i.e. closed and little dynamism or highly dynamic and innovative research environment. Centres of excellence are found to be placed in the latter group, c.f. the discussion in section 4.

Figure 1. Factors interacting with the emergence and development of research environments and the characteristics of the subgroups of centres of excellence



4. Preconditions for excellence in research environments

At the research policy level the study that this article is based on can be used to increase the relevant knowledge such that it becomes possible to identify, and build (or rebuild) the infrastructure that best supports the emergence and development of dynamic and innovative research environments in order to obtain research excellence. The appropriate structures will then be used to intensify the efforts to increase both the quantity and quality of research at the national as well as for the European innovation system.

The development model identified in section B together with the concepts of internal and external characteristics and urban versus rural research environments in section C can be used in this context to

relate the necessary research infrastructure to build up such dynamic, innovative research environments, c.f. figure 1. From the results found some necessary preconditions for establishing dynamic and innovative research environments can be derived, c.f. table 4. The findings can be used in policy recommendations among others. The preconditions are described in three groups, namely organisation and leadership, framework and structures and finally resource allocation.

Building on the analysis of the findings in the two previous sections, dynamic and innovative research environments with a high quality research base, may with a relatively high probability develop to centres of excellence when the characteristics shown in table 4 are present. Furthermore, it seems likely that the concept of urban research environments also can be used to identify research environments with the capacity and ability to become centres of excellence.

It seems necessary for research environments to be flexible and open-minded to survive and develop in the medium to long run. Combined with a strong research-minded leadership, this flexibility allows the research environment to prioritize, reorganise, and cooperate whenever necessary to adapt into the changing framework. However, some framework conditions are better serving some research environments than others. Depending on the stage that a research environment is on, different frameworks and conditions for research seems to be optimal for it. This underlines the necessity to have differentiated national frameworks that best suit the various needs. This can for example be in the form of differentiated funding of research among environments and fields, for example such that basic research gets a higher share of initial public funding compared to applied research that have higher success rates due to its immediate user orientation, that makes it better able to attract external funding.

Table 4. Necessary preconditions that enable dynamic and innovative research environments to become centres of excellence

Organisation and leadership
• Flexible and open-minded; intensive internal and external communication
• Operational research management with possibilities to change strategies and research targets; adapting to external changes, prioritize resources and recruit talents
• Ensure that the private corporate sector is sufficiently aware and informed regarding possibilities and perspectives in cooperative research with public sector research environments
• Intensified and high prioritisation of external dialogue and cooperation with other national and international research environments, establishing of networks as well as exchanging of researchers
Framework and structures
• Differentiated frameworks and conditions for research requirements as well as research environments
• Strengthened organisational development of research environments built on local knowledge of research conditions and needs
• Organisations that allow emergence of new research constellations as a way to ensure innovation and increase interdisciplinary activities
• Time and resources given to research leaders to ensure that they are able to efficiently implement the research strategies; upgrading of management skills among the leaders as an integrated part of organisation development
Resource allocation
• Funding types shall vary between different research environments and fields; Basic research requires more initial public funding while the resulting research has higher success rates for external funding due to its immediate user orientation
• Research environments shall introduce better and varying types of incentives among the researchers to promote the research efficiency and productivity
• Research policy shall differentiate in the funding of well-defined paradigms and new paradigms that are not yet well-defined; The first can have prioritised research fields while the second needs more scope and research freedom regarding choice of research items, funding as well as research productivity

Note: See Kalpazidou Schmidt (2002) and Kalpazidou Schmidt et al. (2003) for a comprehensive discussion of these conditions regarding research policy as well as organisation and management.

The main preconditions for dynamic and innovative research environments seem to be managerial flexibility, communication, and networking, differentiated framework conditions, and funding possibilities as well as differentiated research policymaking. Basically, there is a necessity for broad, stable, and well-known structural frameworks that suit both the reorganisation of existing research environments and the emergence of new research environments. For example, it is necessary to differentiate between public funding to basic research or research in less developed paradigms and to applied research, c.f. table 4.

5. Conclusion

The purpose of the study this article is based on has been to identify aspects to be used to intensify the efforts of developing more and better research environments in order to achieve research excellence and increase economic growth in the medium to long run. A sample of dynamic and innovative research environments has been used as cases to identify the common characteristics that influence their development up to their present stage and research status. These dynamic and innovative research environments were examples of already existing centres of excellence or environments that could become such over time. The study illustrates that common characteristics of the dynamic and innovative research environments can be found internally in the environments as well as in the external research framework. This implies that both sets of characteristics have to be present simultaneously before public dynamic and innovative research environments emerge in the innovation system.

The study identified significant amount of similarities among the empirical cases that made it possible to outline a common development model for the dynamic and innovative research environments. The model contains all types of research environments, although the more static types disappear after some time opposite to the dynamic and innovative that survive in the long run. However, the emergence of research environments has its common origin in fiery souls, critical scientific mass or significant external pressure, no matter whether the research environment later becomes a steady centre of excellence or disappears again.

In the modelling of the dynamic and innovative research environments another common feature was identified, namely that they possess a common cultural and organisational setting that best fits the characteristics that defines urban research environments, c.f. Kalpazidou Schmidt (1996). The dynamic and innovative research environments were open, interactive, transparent, well organised in teams with strategic planning and were productive; all aspects that characterise the urban research culture. Hence, the characteristics of urban research environments seem to be preconditions for developing dynamic and innovative research environments as well as centres of excellence.

Similarly, a combined model of the internalist and externalist perspective defined in section C best described the case studies. Front or top research environments are influenced by external factors too, such as the research policy determined research framework. Similarly, they work systematically to influence these external factors. Hence, a necessary precondition for the emergence and development of well-functioning research environments seems to be an interactive and pragmatic relation to the surrounding innovation system.

All in all, the present analysis has identified epistemological, structural, and organisational as well as cultural factors that need to be present in order to facilitate the development of dynamic and innovative research environments hereby creating a significant stock of centres of excellence in the national innovation system. Due to their generality and reliability, the results may very well be valid for policy recommendations world wide, although probably first and foremost in (western) Europe where the framework conditions for public R&D environments are more similar to the Danish framework conditions than it is the case for other parts of the world.

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3.2. New leadership roles toward knowledge workers

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Introduction

Management of knowledge workers is a delicate balance between motivation and coordination, between playfulness and efficiency. It is also a perspective of leadership, where the manager is responsible for division of labour, but where he is the one of the persons who knows the least about the professional issues. There seems to be two layers of managers, and their roles in leading technology development are very different. The perspective of asymmetric knowledge and the intangible knowledge in R&D open the need for managers to get close to the process of development for more efficient knowledge sharing. The case of a small multimedia firm which has been studied longitudinally for 2½ years illustrates this.

The relationship between management and the knowledge workers represents a structure, where the manager's dependency on the knowledge worker is very high as replicability and explicitation of knowledge are difficult.

The nerds and stars who are the highly valued programmers, and the many young unskilled who are employed and are trained on the job are developing a culture of play, which is probably very efficient to solve certain tasks and to create commitment, but hard to control to make it economic feasible, when projects have to meet deadlines and be sold.

Motivation and coordination is a balance, and the article outline some of the dilemmas, and in what kind of situations it becomes obvious. Such illustrations of different values indicate not only different communities of practice, but also the need for good management to develop only the necessary, rather than the "Rolls Royce model", which may only be sold for the price of the "Volkswagen". In the process the legitimacy of the manager is at stake as economic arguments are not enough for motivation. Management of deadlines and deliveries to be sold has been fundamental for all the IT firms, though some have overlooked this. In the dot.com period the experience has socialised a number of employees to a relaxed attitude to economic management as value of sales and profit did not reflect the value of the firm.

The article is focusing on the management implications of asymmetric knowledge, and how to deal with knowledge sharing for constructing a platform for decision-making and management. The case of de-briefing IT nerds is a point of departure for folding out the arguments, and the special features of how turbulence and rapidity constitutes itself in IT-projects illustrate some of the management problems relative to motivated knowledge workers.

De-briefing on where we are and what we know

Managing scientists lean on the recognition of individual scientists. The notion of de-briefing of spy's comes very close, observing how managers at different levels try to understand what the single programmers actually do, and how this could be exploited in the joint project. The importance is that division of labour, presupposes that the work task is known, and can be delimitated and specified for all involved. Both in innovation and in most IT projects in the early stages, this is not the case, which makes management a very demanding task of coordination on the boundary of knowledge.

The asymmetric knowledge vis-à-vis managers demands some learning-spaces to try to communicate on the content of the work, as to be able to coordinate the consequences for other staff. The process of de-briefing of existing staff takes a lot of time, but is the foundation for transfer not only of information, but also of the level of knowledge as to act and work along the other programmers, and in a research project (Jensen & Monsted 2001b) we have used video registrations of some of these meetings.

Even at a stage without immediate crisis, the project manager has to make an effort at regular intervals to de-brief the advanced developers:
A video-scene where the project manager is trying to find out, what the programmer has been doing. They start talking leaning over a piece of paper. Then the project manager goes to the whiteboard, and start explaining how he interprets, what the programmer is saying. The project manager questions and interprets the answers. After a while they begin to "think together" on possible solutions and interpretations. (Jensen 2001)

The scene illustrates some of the problems of communication and translating codes by the programmer, who cannot formulate in words, what he is doing, or the reflections behind the choices made. The whiteboard is a boundary object in Susan Leigh Starr's (1989) version as a means to communicate and translate the part of tacit knowledge, which is routines and self-evident knowledge to the programmer being de-briefed. The project manager uses the drawings and codes to create a dialogue for understanding the codes developed and the reasoning behind. The knowledge of knowledge workers is thus not in a form that can easily be explained as also seen in tacit knowledge in other scientific work (Collins 1974).

The insight of what is necessary to communicate in order to understand enough as to act, and to make explicit what is evident for the programmer is a complex de-briefing necessary to get an overview in innovative projects. The project manager need the information, not only to give feedback to the programmer, but also to coordinate with other staff, working on other parts of the programme. Division of labour demands that either the manager or the team know the task and can create overlapping knowledge to handle boundaries between the different parts of the programme. The complexity of the tasks makes simple knowledge management impossible and may take a lot of valuable time in an efficiency production perspective. Knowledge is tied to the people and the actions involved, and to communication (see also Stacey 2001).

Another de-briefing scene is described in a video-clip:
One of the "talented" young programmers has a lot of difficulties in telling what he does. He is de-briefed not only by the project manager in R&D in order to keep a customer perspective, but together with another strong programmer, who is one of the owners.

The problem in this scene is that the "primadonna" cannot formulate in proper words what he is doing in a way which is understandable even for the competent project manager, who has programming skills. The other "star" has to participate in the de-briefing, both to help translate and to co-think and develop. They follow up with supplementary questions to get into an interpretation of codes and consequences, and of the choices made in the sections of the programme the programmer works on.

The ability to put in words what the codes mean, and how they link to other programmers, and application work is rather limited. In this case they are not stupid, but it is a totally different language and culture, and translation to explain interpretations becomes important as a part of the joint development and interpretation of the project as organisational knowledge. Beautiful codes are not the purpose of the firm. Codes have to be used, and the young talent often has to be reminded about users. He puts a “post-it” on the screen frame “Remember user”. The application is essential for a firm, which is not a research lab, but has to sell the products, and their applications. The dilemma between the need for programmers to play on the forefront and the need to do the necessary only to make price-competitive products is evident.

The scenes illustrate some of the fundamental problems of what firms know, and who knows what in the firms. The illustrating cases are from very small firms, but the boundaries between the groups of people are very similar to the boundaries between communities of practice or in tight networks. The problem is tied to individual learning, and has to be a social or organisation based knowledge. It is tempting to go into the discussion of transforming tacit to explicit knowledge (Nonaka & Takeuchi 1995), or translating one form of explicit knowledge in the form of codes to another form of explicit knowledge in the form of communication in words of what is achieved and the purpose of the codes. The translation is used in order to overcome communities of practice, and communicate across professional groups. Such translation is not really the same as the perception of tacit knowledge in Nonaka & Takeuchi (1995), but much more communication and learning across communities of practice or across structural holes in networks for complementary knowledge (Burt 1992, Moensted 2003).

The de-briefing in this case was seen as a communication of socially bound knowledge across cultural and professional barriers. The perception of knowledge is not just a translation, but is closer to Stacey’s (2001) perception of creating knowledge, not only as a mental individual map, but also as a social process constituted by communication. The de-briefing is not only an effort to get knowledge as a ready formulated ‘thing’ out of the head of the programmers, but an effort to create a learning space to get the codes into a perspective of creating knowledge about codes, purpose and consequences for other parts of the system. Managers have to constitute meaning in the fragments of information, and this is a social communication process (Weick 1995).

The asymmetric knowledge is a management problem, which is directly affecting the project management, but also affecting the manager responsible for the external relations and economy. The researchers or developers do not feel the same need for communicating beyond their group. As individuals with a specific responsibility, they can “see” where they are going. The need for complex coordination in a larger perspective is not necessarily the perspective of experts or developers. The autonomy and self-management, does not in this case lead to a feeling of responsibility for the organisational perspective.

Management and leadership under these circumstances demand a high level of communication and awareness of interpretations in other communities of practice. The way the de-briefing is functioning is providing a platform for the manager’s credibility for coordinating and getting the economic framework accepted. If the manager cannot get through to the understanding of what is going on, the personal credibility is at stake, and it is even more difficult the next times, where de-briefing is necessary. The communication across professional boundaries is based on trust in the other person’s competence. Respect for other epistemological capabilities could be seen as a negotiated process of creating legitimacy, trust and meaning (Newell & Swan 2000). If the manager does not maintain his respect both at a general management level, and in relation to the concrete scenes, then the framework for a joint sense making cannot be created, and misunderstanding may occur, as we have seen in the case.

The effort to understand the work of the programmer is a necessary foundation for creating the division of labour in the team, but it is also one of the ways to create a communication and mutual credibility. If the manager is not involved in this way he may lose his own credibility, because he is not even making the effort to try to understand.

In the cases the top management became more and more marginalized due to the lack of insight, and lack of interest for understanding the development work, and efforts of cheating are tempting. The perspectives illustrate some of the problems of creating management as a social construction in firms. If a joint framework is not established, the play and art culture may go undisturbed from the limits of the economically motivated deadlines leading to economic ruin.

The levels of management are important to keep separated, as the roles of the closest project managers become more and more important, both to coordinate at the project, but also as the bridge and translator to other parts of the firm. Even if project managers often have very changing and fluid conditions for their work, they are close to the R&D and production, and this is the foundation for their influence and leadership in the organisation. The cases of the top management was more to set the rules and the framework, but even this level have to be related to the understanding of the conditions and timing of development.

Project management in time dilemmas

At the level of project management in IT-projects, the turbulence and time pressure is extreme, and often changing and tightening during a project. Uncertainty on technology has to be dealt with, and raises the questions as to the needed overlap in skills, or the technical insight of the managers? The uncertainty is both tied to technology, the time perspective for new development, and to the customer relations, where customers change projects and conditions especially in the first period of the project.

When crisis management are becoming and perceived as “normal”, a number of regular project management tools become obsolete, and a number of good management reflections and coordination are lost. The case presented may be extreme, as everything is crisis management, but it raises a few questions on how knowledge workers handle and have to handle responsibilities in coordination at many levels. It raises the question on what kind of management can cope with impossible situations? In the dot.com bubble, a number of firms managed to create projects with a very high an unrealistic level of ambition. Such ambitions and ideas actually inspired authors on project management (Kidder 1981, Christensen & Kreiner 1991), and created a special motivation of doing the impossible. An example of this role:

A newly recruited project manager manages a large project of making a PC-based learning system. The firm had never before had such a large project. The sales manager has promised too much, and they decided in the firm and with the developer that they can do it, even if they have to develop the tool, and are forced not to use the existing tools normally used. It appears as a totally impossible task. The new project manager starts building up a unit of production team making text and drawings. Most of these employees do not have much education and have to be trained on the job. The balance is to grow and get the right staff, but also to balance out the communication with the programmer responsible for the tool “producer”. Her tools from informatics and the business school, and a large GANTT scheme tried to get an overview of the complexity, but only for the application side of the project, as the tool development was dependent on the developer. The effort to mobilise motivation and energy among staff was one major aspect of the job, which managed to finish, but not on time.

The awareness of the problems of management on the boundary of the xml- tool “producer”, and the application, demanded a few more recruited for the tool development and adjustment to the application “Learning”. The clash between the autodidact artist developer and the educated and the recruited structured developers revealed the basic problems in the project. The two new recruits demanded a proper briefing, if not they were going to leave, as they could not get into the role they were supposed to do. A time-out for debriefing of the developer had to be accepted in order to allow new developers to work in the programme, as they could not read the mind of the original developer.

The complexity of the knowledge in IT makes several practitioners to state that recruiting more people increase the time used on the programme (Brooks 1995). The complexity of sharing knowledge within IT projects makes it difficult to make explicit what the firm knows. In complex tasks a lot of time is used on learning and exploring. The costs of introducing new staff are very high, and need a long period of training and adaptation, making it extremely difficult when new staff is recruited to speed up the process, as it may demand more time to train than the new staff can create of value added (Brogren 2000). The development based on curiosity takes long time and in an efficiency perspective of production, this is highly time consuming and maybe inefficient for production, though it depends of whether the focus is on creativity and innovation or on efficient production. The knowledge workers and managers do not always agree on the level of "new ideas" and rethinking needed. In relation to knowledge workers the innovative part is motivating, and thus difficult to eliminate if the commitment should be maintained.

The complexity of the project is increased by the parallel development of tools and applications.

Figure I: The flow should in a linear time process be:

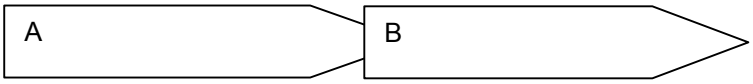
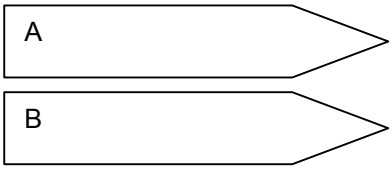


Figure II: There is no time to wait for A to finish and B is cut and placed parallel to A



Based on drawing in Jensen & Monsted 2001b.

The project manager is "the helmet man" balancing between Scylla and Charybdis (Hampden-Turner 1990). She is managing a project dependent on a tool, which is not ready yet (A). Usually the 'producer tool', would be first, and the application for Learning would follow (B) as shown in Figure I. Managers at several levels should try to coordinate this process. As the timeline is "folded" to a parallel process, there is a need for communication and coordination between the tool (A) and the application (B). The need for communication and coordination increases both at project management level, but also on other levels of management, but at the same time the means of control for project managers as well as top managers are meagre.

The work in such parallels, where the project manager is managing and getting an overview in an enormous Gantt scheme, and recruiting and training new staff, without much education, while the tool development for a long time is only "a-one-man-army", with talent and ability to correct and understand the application side, but very unstructured or rather un-explicit on the development process itself correcting at night and developing at daytime. Applications are developed as a separate process on the basis of the "black box". Strangely enough the firm managed to deliver the product, not in time, but still to the satisfaction of the customer.

The coordination and management of "black boxes of the unknown" is appearing in other cases of these firms as well. The barriers of communication and learning over communities of practice are a problem, when knowledge is asymmetric, and the mutual dependency is still a dominant feature in the organisation. The challenges and thrill of an R&D project are motivating factors, which may even motivate to elaborate and change standard tasks to R&D as to get a motivation for these jobs. Even if the parallel development is not efficient, and is creating both errors and stress, it is also creating a "gut-feeling" and motivation for the

project. Such motivation is harder to feel, if jobs are more standardised, especially with an emphasis on timing and deadlines.

Within IT however, turbulence and rapid change in technology is a dominating feature, and creates a very special perception of time. Evaluating time in a non-routine work is risky business that most innovative projects know. Strangely enough it is seldom an exceptional short time, which is the big surprise. When time-pressure is so high and compressed as is normally the case, many tasks have to be done parallel, which would otherwise be linear, as the second part depend on the first. The lack of time for linearity is a new feature, which is not only putting pressure on production but also on both R&D and especially on management coordination (Jensen & Mønsted 2002a). In research management, one of the top research managers said "I did not expect earlier that I would go around to R&D engineers and talk them out of linear thinking. There is no time for linear thinking." The research manager is an engineer himself.

In IT the time pressure creates cases of parallel development of tools and applications, not only makes coordination extremely difficult, but stresses new management roles as coordination is not only between two separate tasks that have to be combined afterwards, but communication is an embedded part of avoiding redoing many aspects of the two tasks. It is interpreted in a systemic innovation perspective, then the constant coordination of the boundaries is necessary, a translation between relatively independent productions, and with very different skills and competence in the two projects. The learning experience as to allow for more time, but then the price is too high for the offer.

The turbulence of IT projects provides new perspectives on time. The rapid development and turbulence does not change everything. It is not a radical change every 3rd months, then programmers talk of new programmes and changes. Turbulence and renewal imply that certain aspects change rapidly, but a lot of features remain. The time perspective could maybe more be seen in a biological way of perceiving change, as a seasonal and age change, where the main structure is still the same, but many features change and have to adapt to seasons or ageing (Adams 1990). Such perspectives on time could be helpful when considering IT projects, living with the intense and drastic turbulence and pressure from new technology and new methods. New methods may change a lot in a project, but changes are mostly recognisable patterns for the community of practice working within the field. The turbulence and "panic solutions" put pressure on managers and on the communication between developers and managers. Both parties are stressed and take chances, which are sometime good decisions, but not necessarily reflecting efficiency.

The problem of time has more dimensions, as the engagement of developers as experts; imply that they want put too much time into the work, and a lot of time in the creative part of the solution. It is hard to manage, as the profitability is tied to the capacity to meet deadlines, and the necessary solution. The overtime used, should be "free research time at night", when it is not part of the deal, and this is often the case.

Knowledge intensive firms and knowledge workers

Knowledge intensive firms are to be interpreted as a "system of persuasion" rather than being production units based on expert knowledge (Alvesson 2001). Expertise is not an objective characteristic, but a function.

In IT firms the ability to persuade customers about expertise, to create credibility and selling ideas is fundamental for the survival of advanced technology and service firms. The value of the solution is seen only if it works afterwards in the application. This is a dominant feature of all service and immaterial production (Normann 2000). The skills to persuade customers are usually not the developers, and would demand skills from other fields as to explain the applicability.

Knowledge workers could be defined as highly educated professionals, which is a quite normal way of defining knowledge workers (Alvesson 2001 p.863, Davenport & Prusak 1998, Newell et al. 2002). The highly educated who work in non-standard settings and have to innovate or analyse and reflect independently form a special group, and demand autonomy and authority of their expert skills. Some professionals have more routinized work, and may act on the basis of existing knowledge, as would be the case with lawyers, some engineers and architects. But professionals also in these professions work on the basis of their expertise, the insight and skills needed, which demands professional minds rather than databases or robots. The group of knowledge workers who independently exploit and explore new knowledge is maybe essential for the understanding of new conditions for management. The innovativeness and unpredictability of knowledge workers in IT development demand a capacity to create meaning in dialogues, and thus create knowledge as learning in dialogue (Stacey 2001).

The skills of knowledge workers for such projects include the capacity to evaluate relevance and potential of knowledge. The ambitions of managers and knowledge workers may not be the same, as R&D projects or consultancy projects may “slide away” and expand to “interesting related issues”, and thus take much more time.

Skills in many knowledge firms are hard to define in terms of educational competence, as with consultancy and IT-programmers, experienced-based learning play an important role. The autonomy of knowledge workers to define what is relevant, interesting and necessary is hard to control and judge for people outside the profession or community of practice.

In IT firms, the skills of developers are hard to define, as mostly it is a description of practice and knowledge of existing programmes, but the ability to solve new problems within a certain sphere of programming is essential. Within the community of practice of the highly skilled programmers, stories and metaphors of work and codes are closer to art than to science. Methods and solutions are described by “the beauty” and elegance. Between programmers they know that the elegance has something to do with efficiency, shortcuts and new possibilities, as one of the managers in a small IT firm said:
“The difference in efficiency between a good programmer and the excellent talent is 1:20, and this is not found in many other types of skills or work”.

This difference adds to the perception of IT appearing more like art, than science. The ability to imagine possibilities and to start creating them is very close to artists work, and maybe managed in the same way. If they are efficient there is no conflict to management. But a conflict arises from problems of time limits. What solution is possible within the deadline? This is a question of the necessary solution, rather than the best solution. Such compromise does not create much motivation or commitment.

The problem seems to be to exploit the talent of the super-expert, where the structure and people should stimulate talent, but also to create a framework for communication of consequences for the dependent people. Leaders have to be engaged in these processes, and assist the creation of frameworks and direction. In the cases observed, the project managers did this, but top management lost track of what was going on in the projects, and became marginalized.

Skills in programming may be acquired as engineers, mathematicians, physics, or in informatics, but some of the talented programmers are autodidacts. This is not seen in other professional knowledge firms or disciplines. The IT field in multimedia production also include a large group of “unskilled young production workers”. Some from such groups have talents for programming, and a high commitment to learn in practice. Generally however these unskilled need to get very well defined jobs and instructions. The way of organising in the two groups is very different, and in many ways only the developer types are considered knowledge workers with decentralised responsibility. The unskilled group needs other types of instruction and management, some even in a very tayloristic and task-specific manner.

The organisation of work in knowledge work responds to the demand for dialogue, self-management and distributed knowledge. The organisation as a system of distributed knowledge as developed by Tsoukas (1996) illustrates the way tacit knowledge and explicit knowledge is intertwined and mutually dependent. The tacit knowledge is hidden in routines and presumptions about the work, as illustrated by Latour & Wolgar (1979) and Gourlay (2002). This perspective stresses the importance of a community perspective on knowledge (Newell et al. 2002, p.107), but also the complexity of sharing knowledge, which is dynamic and fluid, and socially embedded.

Management of knowledge in IT demands a certain understanding of the field, but not necessarily with know-how for actions. Understanding the principles and knowing how to act is not the same thing (Garud 1997). The essence for management is an understanding of implications of codes, as to create conditions for a division of labour with other staff. Decisions have to be taken before knowledge is certain, often at a stage of ideas and ascribed potential meaning of new ideas (Garud 1997). IT systems are very interdependent as system development, and with a high level of complexity and system dependence, the competence of the team and the management is to have knowledge of more than the part, they are working with just now (Kogut & Zander 1996). The mutually dependency in systems, demand much more coordination for integration and managing consequences for other people, than the multidisciplinary aggregation of solutions (Newell & Swan 2000).

Management of motivated knowledge workers

The self-management of knowledge workers and the loosely coupled organisation increase the need for coordination and knowledge sharing. The recent high focus on knowledge sharing reflects the needs for knowing what the organisation knows, and for creating occasions to share knowledge. The flat organisation and high level of decentralised management has an embedded problem of coordination and overview, which is easier in hierarchical organisations. Loose couplings in organisations create a high level of flexibility, but at the same time lose knowledge and overview. Newell et al. (2002) argue that managers have a more narrow span of control, and that subordinates control their own activities, and continue: ”… middle managers are no longer able to act as the communication conduits within an organization – they do not know in much detail what is happening within their particular sphere of responsibility nor do they necessarily have time to engage in such activities” (Newell et al. 2002, p. 101). This implies, that “ the very same organizational forms that help to nurture knowledge creation also provide more opportunity for knowledge loss” (ibid.). In a management perspective, the problems for middle and top managers to get close to technological knowledge, also provide a structure with high emphasis on the first-line project managers. The knowledge workers own responsibility and the team-leaders and project managers are crucial during the stages of high uncertainty, where the “impossible is created”.

The knowledge sharing is not only tied to the individual and the internal relations in the firm. In IT systems, the network and contacts to other talents is an important part of the intellectual capacity. The talent of developers is not only individual, but as the scientific and technological human capital is dependent on the social context “Much of this capital, especially that aspect that is interpersonal and social, is embedded in social and professional networks, technological communities or knowledge value collectives. ….. none of these discounts the more traditional aspects of individual scientist’s talent… Our concept simply recognizes that in modern science being brilliant is only necessary, not sufficient” (Bozeman, Dietz and Gaughan 2001 p. 724)

Management in knowledge intensive firms is less a position than action, stressing the ability to facilitate and create the context and motivations to create knowledge intensive products. It becomes more like the network manager, who is only the manager by acting and by being accepted by the partners as a manager (Moensted 2003). The position and control aspects of the manager role are loosened considerably. Yukl (1989, p 252) stresses the increasing emphasis on shared leadership within leadership research. The profile

of knowledge workers and their wish for autonomy creates a knowledge-sharing context, where leadership is tolerated, as long as the manager is credible both in his acting and as a person and does not set too many obstacles to the part of work which is interesting and fun. The platform for management has to be defined in the context, and a power base is not positional, but has to be created by the leader of the game.

One of the problems is more fundamental, as the cases also reflect some of the dilemmas of coordinating between different communities of practice (Wenger 1998), and between disciplines. The manager coming from outside represent a different community of practice, and the IT developers usually form their own understanding of relevance, competence and organising. When self-managed knowledge workers refuse to accept management, they continue as they had done before, and then even less is coordinated, as authority is not accepted. It is a very dangerous situation, and emphasises the need for capacity to communicate and create a human resource environment for knowledge sharing and mutual need for coordination. In may ways such traits may be found in other institutions as well, in research institutions, but the difference to the IT-world is the “self-identification” as artists, and not accepting a role as highly educated who understand the need to communicate and organise the knowledge. The arrogance of the IT elite-developers reveals a culture of technical brilliance, autodidacts, and a culture, where the dependency on people with these special talents, create acceptance – maybe also too long to live with this kind of anarchy.

The reaction of the developers in many ways illustrates some of the problems of the “playfulness” and ways of working in the dot-com bubble. It is a very irresponsible way of working in a firm, as it is not “only a playground”. The lack of responsibility of the decentralised authority cannot continue, and in this case it ended.

One of the problems seems to be that a joint communication platform does not exist, and that the leader has not managed to constitute an accepted social platform for power. If the managed do not accept the power of the manager, the manager becomes an extra layer and barrier in the organisation, as others will take over decision making. The power game is one of the dimensions of management and leadership, and knowledge workers who are self-managed to a high degree, does not accept positional power alone, it has to be linked to some kind of personal power and credibility (Haugaard 1997, p. 31, Yukl 1989 p.254).

The problems of decentralisation, the need for deadlines and for generating economy in the projects is fundamental, and methods to control are partly the same as always, as recruitment and laying off people is still an option. More than ever, it is important to create a joint platform of understanding and a bridge between the communities of practice. It could be that the knowledge workers can decide on methods and more incremental issues, where other decisions involving other people, and other groups in the firm, have to be communicated and decided at management level as well. Communication is the foundation for such decisions.

Motivation and control

In a knowledge intensive firm the dependency of managers’ credibility and trust is serious. The positional power of managers is limited in small firms, and the personal power stemming from the person and the expertise are essential (Yukl 1989, p. 254). The ability to persuade externally is based on internal knowledge, and internally the insight depends on ability to communicate and create credibility. When managers are recruited to complement skills, and supply insight in economic issues and contracts, their knowledge can only be used in action, if they can relate to the subject matter and the real deadlines of both R&D and production. Credibility is easier accessible within the same disciplines and communities of practice, but also the demand for other skills in management create diversity and boundaries. When communicating across disciplines, as many professional managers do, it is even more important to question and de-brief to get a platform for decision making, which may be recognised as relevant by the knowledge workers. If

credibility is lost, the hidden more than the tacit knowledge is kept hidden for decision makers in the firm, and the credibility of the efficiency measures may be at stake.

A small IT firm may have more than one owner, with different management functions, and some projects leaders who also participate in most decisions. Such structures are part of the knowledge work, and its organisation. The hidden knowledge is seen even in large corporation, where R&D workers may get a green light to start a programme, but deliberately keep top management in the dark in the stages, where the project is very 'experimental'. Only when a new project begins to look less chaotic and more organised it may be "sold" internally in a political legitimisation process (see also Staudt 1997).

The project manager has to create legitimacy as manager, both internal in the group and outside the group. The project managers are more like the developers and may easier get internal credibility in their group, but also have to be able to communicate and get respect upwards. The conditions within the IT market, often imply that the time pressure and resources are under constant changes, and project managers are also part of the stressful game of both redoing and adapting to new conditions, and create efficiency to limit the innovative and beautiful solution for the necessary solution. Project managers have to adapt to new and stricter conditions at regular intervals, and have to negotiate and motivate in their teams to keep up motivation and energy in the critical moments. Even if project managers are close to developers we have seen problems of asymmetric information, and lack of insight in the system-programming, and how such features have to be translated and caught early in the development.

The role of management in knowledge intensive firms could be seen as a negotiation and social construction of power in the communication with the people subordinates. Power is given by the employees, and constituted in the community. Motivation has to be constituted and motivations are not linked to "efficient work on the necessary", but the chance to elaborate on the best solutions to explore and learn. Interviews with Christensen indicate the need to remain playful on the challenges of development. "if not, they could just as well have a 40 hour job with one of the large firms" (Christensen & Monsted 1999)

The knowledge workers are doing more than they should do, in this way they overdo solutions, and keep on the track of artisan work rather than industrialise and recycle solutions. The work is a part of the self-identification and motivation is tied to being on the boundary of the new. Such conditions create creativity and research-like conditions, but are paid by overwork, which is not necessarily paid.

Conclusion

The empirical case in the article is used to raise questions on roles of management in knowledge intensive firms as well as try to use and illustrate a method of videointerviewing. The knowledge intensive firm is based on mobilising knowledge workers. Being loyal to the perception of this kind of firm as a 'system of persuasion', and managers have to follow these rules as well as the other members of staff. In a development process, where new knowledge is created, the lack of shared knowledge is detrimental to the organising of the firm, and new roles of managers have to be found.

The project manager's de-briefing of developers in IT firms in order to get organisational knowledge for managing is used as the illustrating case. The de-briefing is not only a translation of codes, but also an effort to understand the context of codes for managing division of labour. The explicitation of knowledge in these interviews is a very complex task, and demands a high level of insight and ability to communicate across disciplines and communities of practice. The sharing of knowledge is specially difficult in some high tech communities, where only the experts understand what is going on, and the manager belongs to another professional discipline and community of practice, but (s)he has to coordinate and decide.

The understanding of the necessity of management is very different in the various groups, and reflects not only difference in conditions of work, but also in education, interests and the level of playfulness of the dot-com generation. The IT-field is not dominated by highly educated as other knowledge intensive firms (Alvesson 2001, p. 863), but have a lot of the same features and other types of experienced expertise. If the knowledge workers are motivated by factors, which are related to “artisan” production, rather than industrial standardisation, then managers will have to balance out motivation and efficiency. The over-doing work could be an interesting issue to study in other knowledge intensive work as well. Maybe motivation is working on good solutions, but economy is in the necessary solution.

The role of leaders in knowledge-based organisations is tied to the social skills of forming bridges to use the complementary expertise. The more the researchers or developers are technical nerds, the more the manager has to work on creating knowledge sharing, and a platform for communication and for negotiation. Individual talent has to be organised in a structure to be applied and exploited, and this is the role of the manager.

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Chapter 4: Models and scenarios as instruments

4.1. The research performance function

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Abstract

Research management can be applied and studied at different levels and different perspectives: at project level where the perspectives can come from the individual researcher, the project manager, the department manager or the society; at department level with similar numbers of perspectives, etc. The Research Performance Function (RPF) is based on empirical studies where different perspectives were included and RPF draws on insight from different theoretical perspectives. RPF combines input to the research process with all the decision-levels that have to be taken into account for research managers and transforms it to the research output. RPF can be used as a structuring tool when research management and research systems are to be studied and evaluated.

1. Introduction

The Research Performance Function (RPF) emerged as a result of the research project Research Management under Change (ReMaC)[47] where the actual research management at Danish public research organisation were the main focus. The ReMaC project was based on a number of empirical studies (Langberg et al. 2000; Langberg 2000, Langberg 2002a; Langberg 2002b; Andersen 2002) and different theoretical frameworks (Romer 1990; Nonaka et al. 1998). Beside the integrated parts of ReMaC the RPF was also inspired by results from other empirical and theoretical studies (Kalpazidou Schmidt, Evanthia 1996; Kallehauge et al. 1998; Kallehauge et al. 1999; Jacobsen 2001, Langberg and Lauridsen 2001; Lauridsen 2002; Graversen et al. 2002, Kalpazidou Schmidt et. al 2003; Etzkowitz et al. 1997; Ernø-Kjølhede et al. 2001). The initial presentation of the Research Performance Function (RPF) is found in the final report from ReMaC (Langberg 2003a). The presentation below is partly based on this report.

The concept *research management* can be applied at a number of levels. Decisions on minor parts of research projects have to be taken *within* the frame of the project with regard to the overall aim of the project, resource limits, etc., these decisions are often taken by individual researchers, by the project manager or both, and they are based on scientific knowledge and experience. The next management level consists of decisions *about* the projects: to start or stop a project, decisions on how many and what kind of resources that has to be allocated to the different projects, etc. The decisions *within* and *about* the research projects are taken within a structural frame consisting of university structures, structures of funding, tradition for collaborations, etc and can be labelled as the direct level of research management. Above the direct level of research management the medium level of research management is found: at this level head of (larger) departments and centres, deans, head of universities (rectors) are found; those levels are within the research organisations. The societal research management levels are (or can be) outside the research organisation those levels consist of the research policy of government, organisations and councils and are often interacting with economic structures.

[47] The ReMaC project is a REMAP-project.

All research management levels interact with each other and a number of individuals as well as organisations might cross the level borders in different ways.

Input to the research process is different forms of resources as ideas, employees, labs, etc. and output is articles, patents, teaching of students, etc. Input to research can be managed and transformed to research output in a number of ways, the RPF describes this in a structured set up.

2. Research Management at different levels

Research management is found at a number of levels: from management and decisions on minor parts of research projects, via projects management and management on research strategy at the department, centre and/or university or organisation level, to the overall management of a larger area, e.g., research policy at a national or international level. The different levels interact in different ways partly due to organisational and economic structures and partly due to the number of active research managers that cross the borders, e.g., a university research manager might also be a member of a research council. If the research management are to be studies and analysed the level of research management must be taken into account reflecting that different forms of insight is needed on different levels.

The management *within* and *about* the projects might be divided into two different forms of management: the scientific part, where decisions are based on scientific knowledge and the knowledge management part, where decisions are based on insight in knowledge growth, leaning, human resource management, etc. Even though the two parts have to be integrated in the actual management of the projects and thereby differ at different places, the knowledge management part of the research management might be the same regardless of scientific area. To study this a number of different knowledge management and/or human resource management approaches can be taken (Krogh et al. 1998, Huseman et al. 1999, Colarelli 2003) among those are the *Knowledge Spiral* -concept as formulated by Nonaka and Teuchi in 1995 (Nonaka et. al. 1998).

The knowledge spiral is based on an idea of four modes of knowledge conversion: socialisation, externalisation, combination and internalisation where the socialisation implies tacit knowledge exchange, the externalisation conversion of tacit knowledge into explicit knowledge, the combination implies combination of explicit knowledge and internalisation implies that explicit knowledge is converted into tacit knowledge. The spiral focuses on the change of modes: from socialisation to externalisation via dialogue, from externalisation to combination via linking knowledge, from combination to internalisation via learning by doing, and from internalisation to socialisation via field building. All elements in the knowledge spiral concept can be applied to specific experience from the research sector:

- Establishing of ‘coffee tables areas’, placement of letterboxes, etc. can be regarded as a support to the informal knowledge exchange that is the basis for the socialisation process. Elements that all were mentioned by a number of research managers when interviewed[48].
- There is a long tradition for formal seminars and workshops within specific time interval at research institutions, this can be regarded as support to the socialisation process, support to dialogue as well as a support to exchange of explicit knowledge, i.e., combination of explicit knowledge
- The integration of experiments within the research process can, as well as the teaching practice at some universities can be regarded as learning by doing processes
- The mobility among researchers. The mobility can be regarded as a way to exchange knowledge between individuals as well as systems (Langberg and Graversen 2001)

[48] Interview in made by me in connection with the ReMaC project (Langberg 2003) as well as at the dynamic and innovative research environments (Graversen et al. 2002).

- The research process at a number of research environments can be regarded as a continuous process that follows the spiral

The ‘medium level’ of research management, i.e., the level between the research project management and the research policy level that consists of head of (larger) departments, centres, head of universities (rectors). This management has to focus on development of overall strategies and to balance the pressure from the individual researchers on one side to the demand from the society on the other. At this level management systems or tools can be used: either systems that captures a number of issues at the same time eventual inspired by the Balanced Scorecard (Kaplan et al. 1996) or by the idea of Total Quality Management (that later changed into Business Excellence and then to the Excellence Model see Langberg 2003) or more specific tools like benchmarking (Langberg, 2002c) or evaluations (Hansson 2003, Siune and Kalpazidou Schmidt 2003). In some cases these tools are also used on the external level.

In a Danish survey from 2001 (Graversen et al. 2002; Kalpazidou Schmidt et. al 2003) it was found, that all the research managers (at the medium level) of research environments labelled as ‘dynamic and innovative’ were characterized as internationally respected researchers and at the same time interviews showed that they all paid attention to practical human resource management, e.g., they talked about the importance of the social environment when interviewed as well as a number of them were ‘crossing borders’ i.e., they were also members of scientific boards, etc. However the interviews also showed, that most of them have had no formal managerial training.

The research organisations interact with the society in a number of ways. The economic structures, growth and history are on one hand acting as frames for the norms and culture, and development within the research organisations, on the other hand the economic structures are influent by results from the research sector that act as input to changes in the economic structures, research can therefore be seen as one of the factors that leads to economic growth. The development of the research organisations may also be seen in perspectives of interaction between the public research sector (universities), the state, and the private (industrial) sector (Rosenberg et al. 1994; Etzkowitz et al. 1997; Langberg 2003b).

3. The Research Performance Function (RPF)

As argued above research management can be addressed to a number of levels where the research managers, i.e., the direct research managers and managers at the medium level, handle some parts, and policy makers handle other parts, where both groups have to deal with different societal limitations. The actual research systems are functions of former decisions and traditions, and they can be and have changed either directly by the research system itself or the politicians, or indirect by changes in the society around the research systems including changes in the economic structures.

The research performance, i.e., the output with regard to the input used in the research process, is dependent of the initial input as: ideas and other resources to the research process, the actual research management, and a number of external elements.

Active research management is addressed to the transformation process found between the inputs to the research organisation and its output, the core issue for a research manager is then to secure that the inputs are used in such a way that important new knowledge is developed effectively, resources are not wasted, the research conducted is useful at least to someone, and that the research results are presented in such a way that they are available to others. In short it can be said that:

The aim of research management is improvement of the performance function that transforms the constant flow of different inputs to a research performance process into new important knowledge.

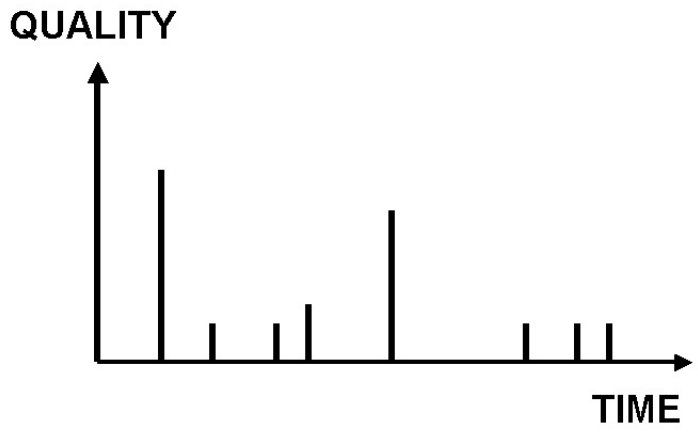
A simple way to understand a research system is to describe a single project from the initial start as an idea and on to the project is either stopped or conducted, this can be regarded as a static research performance function. But research systems are characterised by a number of feed back mechanisms, they are dynamic systems, where the research performance is dependent on the research environment. RPF is therefore a dynamic model as presented in section 3.1. At least three perspectives arise from the model: a perspective for future research management, an economics perspective, and a perspective for the use of RPF in future studies, these perspectives are presented in section 3.2, 3.3, and 3.4.

3.1 The Research Performance Function

The research performance function describes the process where research ideas are transformed to new important knowledge that can be used in other research projects, in other organisations and sectors, i.e., society. The initial ideas and other resources as research knowledge are inputs to the performance function, articles, books, presentations, patents, products, etc., can be regarded as output. Between the input and the output a number of decisions have to be taken, decisions that are based on different kind of information and eventually by different managers – and by the researchers themselves. The outcome of the performance function is dependent on the probability of taking the right decisions at all stages. In dynamic research environments a number of projects at different stages are taken into account simultaneously, some are nearly finished, others hardly discussed, and because the scientific as well as the socio-economic context is changing all along the decisions is taken under uncertainty. Consequently the research performance function is dynamic (Langberg 2003a).

All research projects include an initial idea; these ideas can be regarded as the primary input to the research performance process together with themes and questions combined with resources such as hours of work, technical equipment, laboratories, etc. The production of research ideas is in the core form creative work, i.e., there is no simple function that can describe the way initial ideas are made. But it can be assumed that the amount as well as the later observed quality of the initial ideas are a function of the researchers amount of knowledge in different forms as well as the researchers' *research/epistemological interests*. The initial ideas might be in tacit form, i.e., not possible to pass on to others it is also assumed in the model that the ideas occur randomly, i.e., the idea can be regarded as a random variable. The occurrence and the embedded quality of the ideas could be illustrated as seen in Figure 3-1.

Figure 3-1: The occurrence and embedded quality of primary research ideas, themes and questions



When an idea has occurred the researcher can either drop the idea right away or reflect on it. This initial or primary reflection can be done by an individual researcher or by a team; after this primary reflection the idea

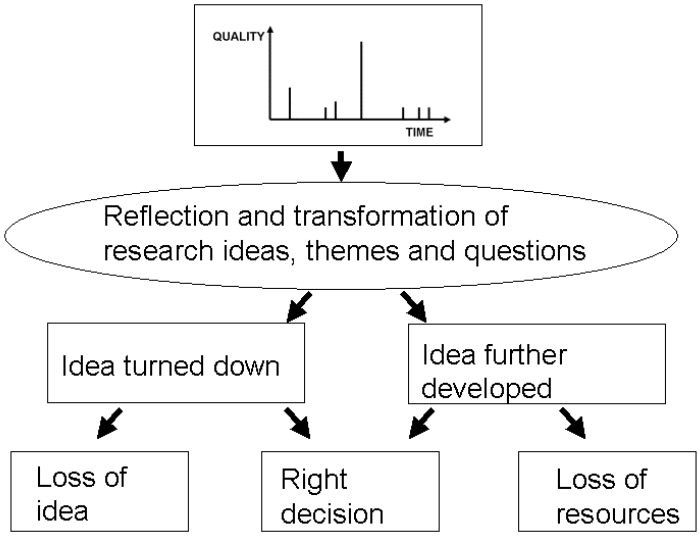
is either dropped or transformed into an explicit form that can be presented and discussed, and further developed or turned down. At this point it is not known whether the idea is one that ultimately can be developed into important knowledge or not; i.e., the embedded quality is still unknown, and the decision is therefore based on uncertainty. The possible outcome of this selection process is seen in Table 3-1.

Table 3-1: Outcome of primary reflection and transformation - primary decision/selection process

		Embedded quality of the idea	
		High embedded quality of the idea: Idea could (have been) develop(ed) into important knowledge	Low embedded quality of the idea: Idea can not be developed into important knowledge
Decisions that can be made	Idea further developed	Right decision	Problematic decision - loss of resources that could have been used to develop other ideas
	Idea turned down	Problematic decision - loss of important idea	Right decision

This process is also seen in Figure 3-2, as seen in the figure the 'right decision' is depending on the embedded quality of the idea as well as the reflection and transformation-process.

Figure 3-2: The primary research input and the first selection process



The initial ideas, themes and questions are discrete, random, and dependent on the knowledge and research interest of the individual researchers. The quality of the primary reflection and transformation is dependent on the knowledge embedded in the researcher presenting the idea and the quality of the initial feedback from the research environment, i.e., the organisational knowledge base and environment. There is

no way to secure that the right decision is taken, e.g., it is not enough to support all ideas, because this will lead to a waste of resources in number of cases and because the funding allocated to research is limited.

In order to have a constant flow of relevant ideas in a research environment the management needs to ensure that at least some of the researchers are capable of inventing ideas, themes and questions. This may be done at the point where the researchers are offered positions as well as in ongoing internal feedback from the research manager to the individual researcher's performance. This might be seen as the first managerial problem. The second managerial problem is to secure that the environment provide proper feed back to initial ideas, this might be done by support of informal knowledge exchange and by the establishment of internal workshops.

The next managerial problem is to optimise the right decisions when allocating resources such as manpower and labs to ideas or themes. Creating well-functioning feedback mechanisms in the organisation is again one way to support this. Supporting the working environment or team working can be an issue just as the creation of formal decision-rules. Therefore, the amount of knowledge embedded in the researchers as well as in the organisation, i.e., the researchers, their qualifications, and the knowledge flow and feedback mechanisms within the organisation, can be regarded as input to the performance process at a number of levels. After the primary selection process of research ideas within the organisation, the next decision is the selection of the ideas that the organisation will promote strategic: what ideas should be developed into research projects that the organisation will support. This can also be described in a table with possible outcomes as seen in Table 3-2.

Table 3-2: Outcome of secondary selection process/decision - idea turned into research project

		Embedded quality of the idea	
		High embedded quality of the idea: Idea could (have been) develop(ed) into important knowledge	Low embedded quality of the idea: Idea can not be developed into important knowledge
Decisions that can be made	Idea turned into research project and supported	Right decision	Problematic decision - loss of resources that could have been used to develop other ideas into projects
	Idea not turned into project or project turned down	Problematic decision - loss of important idea/project	Right decision

But a project supported within the research environment is not a funded project. The funding decision by the internal research management is a double decision: first it must be decided whether or not the project is worth supporting as seen in Table 3-3; second it must be decided how the fund should be raised. Most public research institutions have possibilities to support projects by internal means and most research projects are partly financed internally; e.g., the researchers can use the laboratories or computers, or some of the researchers might be on the payroll of the university while writing the initial proposal. If possible, the research managers will seek external funding to a research project for three reasons:

1. The external funding adds resources to the research unit.
2. It provides an extra quality check of the decision: when projects pass an external programme committee, they pass an external evaluation as well.
3. It is a 'quality sign' to other researchers and research environments, and to other funding bodies.

But finding external funding for entirely new ideas might be problematic, because funding bodies are looking for success stories, and a success for a funding body is normally that the project is conducted with the results that were promised in the project proposal, if the project's main core is an entirely new idea, it is difficult if not impossible to predict the results.

In some cases managers (or collegial bodies) can choose to support projects that have failed to achieve external funding. This can be the case when the sources for external funding are (extremely) limited but the project is essential to the research strategy in the environment, or when the mangers or collegial bodies are more willing to take risks, because they regard it as necessary when acting in an uncertain environment. In some cases new ideas will be partly supported: the researchers will be allowed to use labs or computers in periods when others do not use them, i.e., the researcher will work on the project parallel with other (funded) projects. However, often projects that have failed to raise external funds are turned down.

The actual form and presentation of the research project, as well as the quality of it, is dependent on the knowledge base in the organisation. If the organisation possesses experience in handling external funding and knowledge on funding procedures and priorities, the probability of getting external funding for a project is larger than the probability for a similar project from an organisation without this knowledge.

This is so because an organisation that possesses knowledge on the demand for research from industry as well as the public sector is more likely to seek funding of projects in the right place and time and is more likely to present projects in such a way that they are funded. It can also be assumed that projects that fit possible needs of industry or society are more likely to be externally financed if it is clear to the external decisions makers that this is the case. At this point one could argue that external managers to some extent are taking the 'managerial funding decision' because funding it is (partly) decided by research councils and outside the research organisation and the funding decision is therefore dependent on their strategy. The structures and elements of the funding decisions might therefore differ in different situations and in different systems: in systems where the external funding is relatively large the funding decisions are different from the systems where the external funding is relatively small.

The demand for research seen from the perspective of the research manager at the research institution is a demand from the public as well as the private sector. The knowledge of the demand for research and the impact that research managers can have on demand is essential for managers that are to be successful in the long run. The impact on demand can be accessed by knowledge exchange between the research managers and industrial managers as well as knowledge exchange within the political system, e.g., when research managers interact with the political system they achieve influence on the research policy.

The embedded knowledge in the research organisation at the funding decision level can therefore be divided in different elements:

- Knowledge achieved from experience with former projects
- Knowledge achieved from funding bodies, e.g. strategies formulated by the funding bodies
- Knowledge on the actual research policy
- Knowledge on how to influence the future research policy

Where these elements have different effects on the decision-function depending on the research subject or the research system (university system in a specific area, etc.)

The outcome of the funding process can be described similar to other decisions/selection processes as seen in Table 3-3:

Table 3-3: Outcome of funding decision/selection process

		Embedded quality of the idea	
		High embedded quality of the idea: Idea could (have been) develop(ed) into important knowledge	Low embedded quality of the idea: Idea can not be developed into important knowledge
Decisions that can be made	Research project funded	Right decision	Problematic decision - loss of resources that could have been used to fund other projects
	Research project not funded	Problematic decision - loss of important project	Right decision

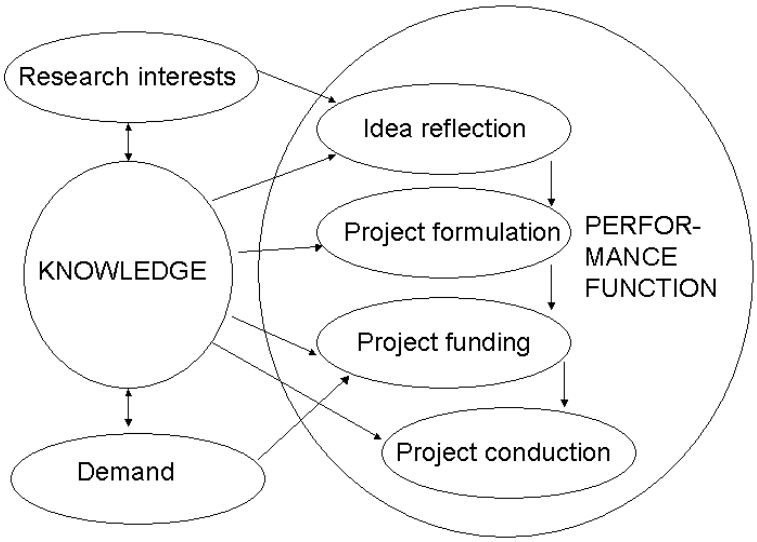
After the project is funded it has to be *conducted and finished*. At this point it can be regarded as a success if the research provides important new knowledge; or it can be regarded as a failure: useless knowledge, or just not finished at the right time. But in any case it may provide a lesson the (local) research environment and maybe researchers from other environments can learn from it.

The performance function of research management is found in the flow between the inputs and the *probability* of development of important knowledge, i.e., success vs. failure. The performance function is seen in Figure 3-3.

As seen in the figure, organisational knowledge plays a core role because *knowledge* has a direct effect on the performance function, i.e., a shift in knowledge level (a shift from one research manager to another) will be reflected in a shift in the performance. At this point this knowledge can be divided into four forms of knowledge:

- Knowledge of the research interests within the organisation
- Scientific knowledge
- Managerial knowledge
- Knowledge of the demand for future research (results) within the specific area

Figure 3-3: The static research performance function



The managers' or the environments' knowledge of the research interests is knowledge on the single researchers' research interests. A research manager needs to have knowledge on researchers' interests for several reasons:

- The researchers' interests are essential to the formulation of new ideas, and knowledge about them is therefore important for the manager when evaluating the probability of reaching strategic goals.
- This knowledge is necessary when a specific demand for research is to be connected with the right group of researchers
- This knowledge is necessary for the manager when (s)he has to decide whether or not the research unit is capable of joining a (collaboration) project
- This knowledge is necessary when decisions are made for appointing new researchers

Knowledge on the (other) researchers' research interests can be spread throughout the organisation via (research-) seminars, workshops or by the use of an internal research information system. The knowledge can also be archived by systematic interviews of the researchers (once a year, on a number of subjects).

The fundamental scientific knowledge in a research organisation is necessary for the actual research performance. This knowledge consists of formal knowledge that could be measured in number of researchers with a PhD within specific areas, number of articles, etc., and informal knowledge that might be measured by mobility, etc.

The managerial knowledge in a research organisation is necessary for the development of the performance. Simple administrative routines like appointments have to be made, bills have to be paid, plans have to be made and followed, contracts have to be handled, have to be in place; research feedback mechanisms as workshops have to be supported, and the management of the human resources needs to be handled. Checklists can measure all three elements.

The manager's knowledge on the demand is also important when specific research interests are to be connected with it; and in assessing how new strategies are to be developed. This impact can be indirect when researchers exchange knowledge with persons from industry on both formal and informal ground, or direct, e.g., when researchers formulate parts of governmental research programmes.

Beside the knowledge that includes knowledge on research interests as well as demand, these elements have their own direct impact on the performance function: the research interests generate the research ideas, and the external demand is essential for the funding decision. One could argue that the manager's knowledge of both the research interests within the research environment and the external demand for research is the knowledge element that connects the two.

If a research system is to be successful, i.e., develop new important knowledge, it is not enough that researchers have important ideas, the right ideas need support (at all levels); and it is not enough that research within specific areas and on specific problems are funded, the research projects need fundamental qualities and ideas.

As argued, the performance function is a function of *the probability of making the right decisions* at all of the following levels:

- When reflection on the idea is conducted
- When the project is formulated
- When the project is supported or refused
- When the project is funded
- When the project is conducted

It might be different researchers or teams that are responsible for the decisions at the first two levels, and it might be other research teams or managers that take the decision to support the project or not. The decision

of funding might be influenced by decisions on a political level, e.g., the research policy might focus on a specific issue, meaning that some projects will achieve a higher probability of funding than others. And finally the success of the project is dependent on the capability of conducting the project, and other researchers than the ones that invented the ideas might do this. A large number of researchers might therefore be involved in successful projects, and their work needs to be coordinated. This coordination is as essential for the results as the decisions made at the different levels.

The point in writing a part of the performance function up as a function of a number of *probabilities of the right decision* is that: if the probability is 0 at any point in the number of decisions, it will result in a probability of creating new knowledge at 0, regardless of the quality of the idea, the capability to conduct research, the embedded knowledge in the organisation, or the other probabilities. Or said in another way: if there is a *weak point* at any place in the line from the primary reflection to the capability to conduct the research, the research idea will not transform into a successful research project.

The probabilities at every decision-point are influenced directly by the research management; a change in research management will therefore change the probability of creating new important knowledge. Some of critical points with relation to the research management are therefore:

- The formulation of strategic plans
- The development of the research environment in such a way that feedback mechanism is optimised, and
- The building of the 'right' research team: a team that possesses the capability of creating and developing new ideas, of presenting the project the external reviewers, as well as a team that possess capability of fulfilling the project to the end, i.e., to the development of new knowledge.

Changes in research performance-function can be compared with technical changes in the production-function in a model of growth with technical changes.

In Romer's growth model with technical change (Romer, 1990) technical change is "*improvement in the instructions for mixing together raw materials*" and "*instructions for working with raw materials are inherently different from other economics goods*"; these instructions are transferable knowledge, and can be given again and again. Romer uses the phrase *non-rival good* to describe technical changes, where purely non-rival goods have the property that its use by one in no way limits its use by another. By definition public goods are non-rival, and one could say that Romer therefore treats research knowledge as a public good. The model is addressed to analyses of production at the national level.

A model with a performance-function within the research sector in the Romer-model can then be regarded as model within the model where changes in the performance induces technical changes.

The model can be described more formally:

If the probability of developing of important knowledge *P(DIK)* is a function of

- A function that describes the research environments capability to **c**onduct research products *F(C)*
- The probability of taking the right decision when the project is to be **f**unded *P(F)*
- The probability of taking the right decision on whether or not to transform the initial idea into a **p**roject *P(P)*
- The probability of taking the right decision on transformation of the initial idea into an explicit idea during initial **r**eflection *P(R)*
- A function that describes the **q**uality of the **i**nitial idea, *QI,* the random function of the embedded quality of the initial idea, theme or question and the initial resources *I*. This function is then written *F(QI,I)*

The model can be written as:

$P(DIK) = [F(C)*P(F)*P(P)*P(R)]*F(QI, I)$

where
$[F(C)*P(F)*P(P)*P(R)]$ is the performance function

The performance function is as described above dependent on the embedded knowledge, *EK,* at a number of levels since the underlying functions are functions of it: $F(C)$ is a function of the embedded knowledge in the organisation *EK* and: $F(C)=f_C(EK, QI)$, etc. as seen below.

$F(C)= f_C(EK, QI)$

$P(F)= f_F(EK, D),$

where D is the demand from the research sector, the public sector in general, and the private sector
$D=f_D(D^R, D^{Pub}, D^{Pri})$

$P(P)= f_P(EK, QI)$

$P(R)= f_R(EK, QI)$

$F(QI,I)= f_Q(EK, QI, I)$

The embedded knowledge itself is a function of the scientific knowledge EK^S, as well as the managerial knowledge, EK^M

$EK=f_K(EK^S, EK^M)$

The simplest way to change the outcome in the above static model is adding a difference in the initial resources or input in the organisation, e.g., difference in number of researchers that will have an influence on the embedded knowledge:

$P(DIK) + \Delta[P(DIK)] = [P(F)*P(P)*P(R)]*F(QI, (\Delta+1)I)$

This difference will then change the probability of creating new important knowledge, $P(DIK)$. A larger amount of initial resources will lead to a larger $P(DIK)$. But a change in the performance function as seen below might have the same effect: if one of the probabilities is low to a start a minor change might even have a large impact.

$P(DIK) + \Delta [P(DIK)] = (1+ \Delta) [P(F)*P(P)*P(R)]*F(QI,I)$

The research performance function is not a static function it is dynamic, i.e., dependent on prior experience. The most important issue here is that the outcome of prior research has an influence on future research in at least three ways:

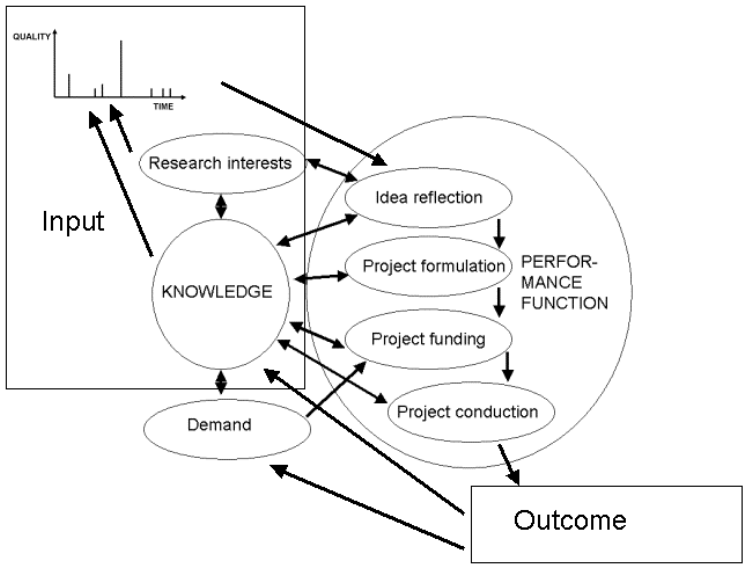
1. Prior research experience adds knowledge directly to the knowledge base (of the individual, the organisation, and other researchers) because research is knowledge production.
2. Each new research process adds knowledge on performing research to the researcher as well as the organisation; an effect know as ‘on-the-job-training' in a labour market context, and
3. Prior research results will effect the funding decisions of future projects.

Research in one period (t) can then be considered as an input in the next period (t+1) in at least two ways:

1. Explicit research outcomes such as articles, patents, books, etc. are input to the research sector as well as to other sectors in the economy, i.e., an input that can be used by a number of organisations. Change in this kind of research knowledge is like the technical changes in the Romer model (1990) for *non-rival goods.*
2. Explicit research outcomes kept within the organisation as well as the informal experience from the research process embedded in the researchers and the organisation where the research were conducted can be seen as input in specific research organisations. This specific form of input exists at all levels in the performance function.

The full performance function is shown in Figure 3-4. The double arrows are immediate feedback; other feedback mechanisms are the knowledge circle, *knowledge* and *research interests* to the *initial ideas,* and the knowledge circle from outcomes via demand and knowledge and back into the performance function.

Figure 3-4: The Research Performance-function with input, output, and feedback mechanism



As seen again demand for research plays a central role. Information on demand might not only channel resources to the research sector from other sectors; it might also transmit general research outcomes as well as other kind of information back to the others sectors and in this way support growth in society. Demand and knowledge on the demand is one issue among others in research management, and focussing on demand might cause a (discrete) rise in knowledge growth.

The embedded knowledge is the core issue if the outputs of the performance function are to be affected by changes in management. One important issue is therefore active knowledge management that supports growth of the knowledge base within the research environments.

Consequently, a successful research manager in the long run is a manager who responds to changes in researchers' *research interests* as well on changes in the surroundings, i.e., demand in such a way that the probabilities of the right decisions are as large as possible. This requires a high degree of scientific knowledge, networking, and managerial skills.

The formal description of the dynamic model can be written as seen below.

$P(DIK_t) = [F(C_t)*P(F_t)*P(P_t)*P(R_t)]*F(QI_t, I_t)$

where

t is the time and the other symbols are the same as in the model above

$F(C_t)= f_C(EK_t, QI_t)$

$P(F_t)= f_F(EK_t, D_t)$,

$D_t=f_D(D^R{}_t, D^{Pub}{}_{,t}, D^{Pr,i}{}_t)$

$P(P_t)= f_P(EK_t, QI_t)$

$P(R_t)= f_R(EK_t, QI_t)$

$F(QI_t,I_t)= f_Q(EK_{t-1}, QI_{t-1}, I_t)$

and

$EK_t = f_{EK}(EK^M_t, EK^S_t)= f_{EK}(QI_{t-1}, D_{t-1}, EK^M_{t-1}, EK^S_{t-1}, EK^M_{t-2}, EK^S_{t-2}, EK^M_{t-3}, EK^S_{t-3}.....)$

Some perspectives and practical use of the model is presented below in section 3.2, 3.3 and 3.4.

3.2 The Management Perspective of Research Performance Function

Two management perspectives arise directly out of the model: perspectives that are important when dealing with practical research management: training of future research managers and perspectives on which individual or collegial body are responsible for decisions at different levels including how these decisions are taken. Said with other words: how the managerial structures within the research organisations work and consequently how the managerial system within the research organisation can be improved.

For research managers the RPF offers a number of practical checkpoints when dealing with the knowledge resource management among these are:

- The research environment access to new ideas.
    - Access can be secured by a constant flow of researchers either by attracting Ph.D.-students and younger researchers to post. doc.- positions, by offering guest professorships, by engaging in research exchange arrangements or by attracting productive and original senior researchers
- The research environment capability to provide proper feed back at a number of levels. This can be supported by
    - Securing that researchers in the environment have the proper scientific and social knowledge
    - Securing informal internal knowledge exchange. This can be done at lunch hour, during coffee breaks, by office sharing (new or guest researchers share office with senior researchers), by open door policies, at social events
    - Securing formal internal knowledge exchange. This can be done by arranging workshops where projects are presented, meetings at department level where the research strategy is presented, and by yearly follow up meetings between researchers and managers.

- The research environment's research resources. This part is closely connected with the actual research system, every system must therefore have it's own checklists at this point
- The research environment's sources for information on future demand for research.
    - This can be by secured when managers and/or senior researchers are involved in knowledge networks, active in different organisations, acts as supervisors, etc. This part is also closely connected with the actual system.

Other aspects have been mentioned in section 3.1.

Research councils and other organisations outside the research organisations can act as external research managers when they formulate research programmes or evaluate research proposals; these councils may also act as indirect managers of the research (strategies) as they act as mediators between society and the research sector. From the societal point of view it is important that these councils and organisations are capable of dealing with new problems and changes in the society. From the research sectors point of view it is important that individuals in the councils are scientifically in front and widely respected.

A development of checklists for different systems gives opportunities for testing the performance of managers as well as the model it self.

3.3 The Economics Perspective of Research Performance Function

If the research performance function model is entered into a three sector model with technical changes like the one developed by Romer (1990) some new perspectives of the model arise.

The three sectors that appear in the model by Romer are:

- The research sector that uses human capital and the existing stock of knowledge to produce new knowledge labelled *new designs* (the focus in discussions of research management).
- The intermediate-goods sector that uses the designs as well as forgone output to produce producer's durables (capital).
- The final-goods sector that uses labour, human capital and the set of producers' durables (consumer goods).

There are two main differences between the elements of the Romer model and the performance function described above:

1. The knowledge is not only explicit non-rival knowledge but also knowledge that is embedded in the research organisations.
2. There is a feedback mechanism from productions sectors to the research sector via the (knowledge of) demand for research.

The main result of this is then that changes in the research sector will affect the rest of society regardless of the kind of the changes, e.g., changes in inputs or changes in the management of the research sector.

If changes in the performance function have an effect similar to the *endogenous technical changes,* it is problematic to use the R&D expenditures directly in empirical functions describing the effect that R&D has on society as it is done in studies based on simple Cobb-Douglas functions.

If the RPF is to be used to improve economics of economic growth, further development of the model has to be conducted.

3.3 The Research Performance Function as a tool for comparing research systems

The RPF offers a structure for analysis of different research systems. First it provides a structure for qualitative analysis of the different decision levels, e.g., analysis of the different decisions levels can be made by case studies of specific projects or at specific research organisations as universities or nation wide systems (an example can be found in Langberg 2003b). Second it provides a structure for qualitative studies of the knowledge exchange system at different levels (project-level, department-level, centre-level, university level, national level); this can be done by focussing on collaboration between different organisations (an example is Langberg and Sørensen 2000 where Danish Government Research Institutes' collaboration with universities were mapped). Thirdly it provides a structure for qualitative empirical studies of different research systems.

Quantitative empirical study based on the research performance function at specific organisations or nation wide system would have to use groups of variable:

1. Estimates for inputs:
- Economic resources allocated to research (relative to GDP as well as totals)
2. Estimates for the RPF:
- The embedded knowledge EK_t This could be indicated by a number of variables like:
    a. Number of researchers
    b. Researchers' education and experience (years as active researcher, mobility etc.)
    c. The managers' education and experience
    d. Type of management
- The probability information available like information on funding P(F)
    e. External grants - success rate
    f. Participation in networks
3. Estimates for outputs:
- Articles, patents, etc.

Eventually the formal RPF could be reformulated in such a way that it can be estimated by the use of latent variable structures (LISREL models).

4. Summary and conclusion

The research performance function (RPF) emerged as one of the results of the research project Research Management under Change (ReMaC) where the main focus was the Danish public research sector (Langberg 2003a). The RPF is based on empirical as well as theoretical studies within research management. It is argued that the research performance is a function based on reflection on initial research ideas, formulation of the research project, funding of the research project and on the conduction of the research project. And it is argued that this reflection, formulation, funding and conduction are dependent on the knowledge in the research organisation. Two forms of knowledge are needed: scientific knowledge and managerial knowledge.

RPF transforms the initial research ideas and other resources into research results as articles, patents and products. The RPF consists of a number of decisions all partly based on the embedded knowledge in the system. The embedded knowledge in one period is dependent of the experience of former periods i.e. the embedded knowledge can be regarded as a function of former ideas, former conduction of projects, etc. and consequently RPF is a dynamic function.

RPF can be used to study and develop research management as well as to develop economics of research impact on economic growth.

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4.2. The Art and Science of Scenario Planning

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The Practice of Scenario Planning

There is no doubt that we live in uncertain times characterized by rapid change. How can one make claims and formulate decisions when looming unknowns and indeterminate information reign? What kinds of filters are reliable to grasp emerging realities? What methods are used to explore the inherently uncertain and unknowable terrain of the future is a vexing problem faced by organizations today. Long term investments into new markets, products and services are a necessary facet of doing business yet the tools to assess future environments are unable to meet standard tests of reliability and credibility. Scenario planning stands out as an enduring practice that has seen waves of proliferation, most recently in the last few years, gaining popularity in policy making circles as well as in commerce and NGOs. The flexibility of the methods of scenario planning is noteworthy and the subject of this investigation.

Many scenario practitioners view scenarios as a means to deal with complexity and develop visions from which to act in uncertain times. Scenarios are typically defined as stories describing different but equally plausible futures that are developed using methods that systematically gather perceptions about certainties and uncertainties. "Scenario planning is a discipline for rediscovering the original entrepreneurial power of creative foresight in contexts of accelerated change, greater complexity and genuine uncertainty."[49] Within this rhetoric we see 'the future' (re)emerge as a heuristic space.

These stories of the future have found their way into business and policy-making as a means to manage the unknown and uncertain. This new take on prophecy is productive, often generated through participatory measures and occupies professional settings. Scenarios are produced by research institutes, consultant firms, national governments, multinational corporations, and from alliances fusing these groups. Their scope can be long or short term. The content of the scenarios can address specific problems, macro trends or national issues. Further, the methods have been employed in a broad range of industries from, for example, insurance, health care, education, energy, to telecommunications. The flexibility of the method is astounding.

A method typically reminds us of a strict procedure or an ordered, systematic way of reaching an end. In scenario planning, we can distill some accepted basic steps to formulating scenarios. A standard process is to 1) identify general, broad, driving forces; 2) develop a variety of realistic trends within each driving force topic; and 3) synthesize the trends into storied futures, or scenarios. However, despite extensive literature on methods in scenario planning, in practice creating scenarios does not rely upon strictly ordered prescriptive procedures. Although there are discernable and replicable steps in the process, there is a great deal of freedom to emphasize, choose, weight and select different elements in the construction of the scenarios, proving the method contingent upon the practitioner, the setting, the kind of problem and the context of the project. The fluidity and contingency of method allows freedoms that range from the initial setting of the problematic situation all the way through to the naming of the scenarios.

This paper serves as an introduction to scenario planning by way of explaining the flexibility apparent in the methods. What follows is a consideration of how and why scenario planning maintains such flexibility and multiple instrumentality while still maintaining a methodological integrity. Some practitioners refer to scenario

[49] Wack, Pierre. "Scenarios: The Gentle Art of Re-Perceiving." [Working Paper] Cambridge, MA: Harvard College, 1984. (Reprinted in *Scenario Thinking Concepts and Approaches.* Training Manual produced by Global Business Network. 25-106). 39.

planning as “more art than science”, and insist that there is “no simple formula” for generating scenarios.[50] Yet others insist that it is a “clearly defined technique” with a “disciplined methodology.”[51] To make matters more complicated, other practitioners cite the absence of a structured theory behind the method. In short, there is much debate over the norms of the method, if there is indeed a method, and on what foundations the method is based. As we shall see, scenario planning is necessarily riddled with ambiguity on multiple levels- epistemologically (knowing and seeing) and methodologically (art or science). This paper concludes with a discussion of the risks and rewards attending the flexibility of method.

Productivity and Scenario Planning

While the most common description of scenarios is a tool for decision-makers, scenario planning is used to accomplish a diverse range of tasks. The method has a kind of practical flexibility that allows work to be conducted in a variety of settings. This section addresses what kind of work gets done. However, note that these tasks are heterogeneous, but not altogether distinct from one another. Where one task leaves off and another begins is not set, but rather is resolved here into these categories for ease of explanation. In practice, it may be that some combination of productive attributes may be described as achieved, while others are ignored altogether. What follows is a tour through the work accomplished by scenario methods.

Decision Making

Many practitioners and authors simply refer to the methods used in scenario planning as “tools for improving the decision-making process against a background of possible future environments.”[52] In this sense, the scenarios, as well as the process that create them, act as heuristics to help define, clarify and work through issues and generate new policy options. The insights generated in the process can be applied to solve problems and develop strategy and help decision-makers consider alternative perspectives to their situations.

Generating Creativity

Other practitioners see scenario planning as a way to enhance or “unlock” the creative potential of a group. Whether in a corporate or governmental setting where innovation leads to greater profit in the currency of new products, or in a policy-oriented setting where creativity offers novel solutions to complex problems, scenario planning is described as method that can “unleash” the creative juices of the team. Here the practice is a means to loosen the creative potential by promoting “what-if thinking” and “imagining the possibilities.” The perusing of the terrain in the future requires a leap into unknown territory where one must speculate and create anew. Participants must make an “imaginative leap” into the future and speculate on what is to come.

Learning

The methods of scenario planning are also conceptualized as tools to enhance learning. Such learning is spoken about on multiple levels, such as individual and organizational learning, in addition to learning about the external environment. “The test of a good scenario” says Peter Schwartz, “is not whether it portrays the future accurately, but whether it helps an organization to learn and adapt.”[53] Often overlooked in the literature, learning occurs not only within the organization, but also by the scenario practitioners. Practitioners not only expand their knowledge of driving forces and the methodology of scenario making, but also develop tacit and explicit knowledge gathered from working within many companies, governments, and influential actors over the years.

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[50] Schoemaker, Paul J. H. and Cornelius A.J.M. van der Heijden. “Integrating Scenarios in the Strategic Planning of Royal Dutch Shell.” *Planning Review*. Vol. 20, No. 3. May/June 1992. 42.

[51] Simpson, Daniel. “Key Lessons for Adapting Scenario Planning in Diversified Companies.” *Planning Review*. Vol. 20, No. 3. May/ June 1992. 10-17, 47-48. 11.

[52] Schoemaker and van der Heijden, 41.

[53] Schwartz, Peter. *The Art of the Long View: Patterns to Strategic Insight for Yourself and Your Company.* London: Doubleday/ Currency, 1991. 33.

Sharing and Gifting Intelligences
Practitioners work to enable a firm to not merely collect and catalog information, but also to transform it into stories, or accessible representations and analyses of what's going on. The learning becomes translated into packaged intelligences to be mobilized and shared. For example, the renowned South African Mont Fleur scenarios were presented to more than fifty groups including the participating political representatives' constituents, academics, churches, companies, and community organizations.[54] For an example from the corporate sector, the Shell global scenarios are presented to such powerful, influential institutions as the IMF, World Bank, as well as to oil-bearing nations and other multinational corporations. Scenarios then work as a kind of currency in the knowledge marketplace and work to build relationships, establish reputations, gain access to other information and accumulate goodwill.

Manufacturing Consensus
The scenario making process is used in environments where multiple social worlds meet to reconcile views and directions by setting the debate in the future. It is thought that the distant setting allows different opinions to thrive amongst a group that has conflicting views of what has happened in the past or what is going on in the present. "Being presented as possibilities rather than predictions are psychologically less threatening to those who hold different world views."[55] Here the methods are framed as a way to help conflicted groups overlook past disputes and consider that they share a common ground of the future.

Disciplining minds and behavior
Generating scenarios is not about listing out innumerable possibilities but rather disciplining the sweeping expanse of the future into a few structured pictures of the future. In this sense, scenarios also act as a basis from which to clarify missions, identities, and trajectories of action by suggesting a few versions of the future and establishing how the company, nation or organization is to move and act within them. Scenarios can serve to inform behavior and offer perceptual guidance for those representing, interacting or responding to the firm thus working to discipline conduct and suggest self-organizing mentalities that allow for consistency.

Building Identities
It is scenarios' likeness to myth or parable that impart a sense of building identities, or explaining who we are. Myths usually function in society as moral guidelines as well as origin stories, stories of becoming and delineations of destiny. Likewise, scenarios can work to establish missions and clarify the identity of the focal group and articulate, for instance, "What makes Shell Shell." The building and communicating of a robust identity is presumed to allow groups to maintain focus and create a sound frame of reference for dealing with the complexity and shiftiness of their business environment.

Sense-Making
In addition to clarifying of purpose and identity, scenario planning is also implicated with the more oblique task of making sense. This sense making is typically addressed in relation to the ordering, filtering, and synthesizing of information. Without appropriate filters or ordering devices, the buzz of information, the vast congregation of disparate or totally unrelated information, often lacks meaning. People and organizations are sometimes not equipped to make sense or determine the validity of each piece of information. A chairman for Royal/Dutch/ Shell, Herkstroter, said, a primary function of the scenario method is to "decipher the overwhelming and often confusing information of the present."[56] Making sense, by ordering, filtering and categorizing information and narrating it for consumption is another task accomplished through the method.

Orchestrating Perceptual Shifts
A very important job of scenario planning promoted by many authors and practitioners is the shifting of mental models, or the orchestrating of perceptual shifts. The mental model may be formed early on in

[54] Kahane, Adam. "Imagining South Africa's Future: How Scenarios Helped Discover Common Ground." In Fahey, Liam and Robert M. Randall (eds) *Learning from the Future: Competitive Foresight Scenarios*. New York: John Wiley & Sons, 1997. 139.
[55] Shoemaker, Paul. "Multiple Scenario Development: Its Conceptual and Behavioral Foundation." *Strategic Management Journal*. Vol.14. 1993. 200.

different circumstances where experience taught one path to success, but another trip will yield different results. The volatility of the market introduces new rules, or at least makes archaic and ineffectual the modes of thinking and plans of action that guided leaders in the near past. Within the scenario planning community, it is thought that our current way of understanding reality, as perceived though our mental models, is outdated, dangerous and blinding and does not grasp the complexity and new dynamics inherent in the emergent reality. When reality is unstable and full of uncertainties, the mental models could be damaging if they remain unchanged and laden with old assumptions. Scenario planning is presented as a method to question such assumptions, make them explicit and to rejuvenate them in light of new circumstances and challenges.

Flexible Production

These descriptions of the kinds of work accomplished by the methods provide an initiation into the practice and tell part of the story of why scenario planning is so enduring. As a management practice scenario planning can do something for everyone depending on need. This kind of practical flexibility has allowed scenario planning almost four decades of popularity. However, the question remains how and why flexibility is maintained through time.

Boundary Objects

The concept of boundary objects provides a useful read of the methods of scenario planning and opens the door to understanding the integrity and durability of the method as well as its flexibility. The term boundary object has been used in the field of Science, Technology and Society (STS) to refer to theories, artifacts, concepts, or practices that demonstrate a practical flexibility while maintaining an identity across sites. Star and Griesemer created the concept of boundary objects to explain how a diversity of perspectives could be reconciled and mobilized toward cooperation in order to do work in the scientific sector. They sought to understand how certain "objects" served as sites to which different social actors attached their own meaning without disrupting others understandings of the object. The objects also embody common meanings that allowed translations and mutual understandings between the social groups. Star and Griesemer refer to "objects which inhabit multiple worlds simultaneously and which must meet the demands of each one."[57] Shackley and Wynne explain boundary objects as "things, people, projects, texts, maps, and ideas that facilitate articulation between different actors or 'social worlds.'"[58] They continue, "boundary objects fulfill their function when they maintain differences across several social worlds in a simple and economic way without making these differences seem so great that they inhibit articulation."[59]

Boundary objects are said to be created through "deeply heterogeneous" processes where "different viewpoints are constantly being adduced and reconciled… Each actor, site or node of a … community has a viewpoint, a partial truth consisting of local beliefs, local practices, local constants and resources, none of which are fully verifiable across all sites. The aggregation of all viewpoints is the source of the robustness..."[60] In other words, boundary objects maintain differences by allowing flexible interpretations and accommodating multiple meanings without sacrificing the shared identity. This in turn strengthens the object, allowing it to satisfy many different needs and move through multiple social worlds.

Conceptualizing the methods of scenario planning as a boundary object usefully begins to explain how the practice can take flight and circulate broadly without loosing momentum or becoming distorted. As a

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[56] Duncan, Norman and Pierre Wack. "Scenarios Designed to Improve Decision Making." *Planning Review*, 22. No. 4. 1994, 21.

[57] Star, Susan Leigh and Griesemer, James. "Institutional Ecology, 'Translations' and Boundary Objects: Professionals in Berkley's Museum of Vertebrate Zoology 1907-39." *Social Studies of Science* 19. London: Sage Publishing, 1989. 408.

[58] Shackley Simon and Brian Wynne. "Representing Uncertainty in Global Climate Change Science and Policy: Boundary-Ordering Devices and Authority." *Science, Technology & Human Values*. Vol. 21, No. 3. Summer 1996, 279.

[59] Ibid, 279.

[60] Watson-Verrant, Helen and David Turnbull. "Science and other Indigenous Knowledge Systems." Jasanoff, Sheila, Gerald E. Markle, James C. Peterson, Trevor Pinch (eds.). *Handbook of Science and Technology Studies*. London: Sage Publishing, 1995, 127.

boundary object, the methods become meaningful in different ways in different settings. When different social groups come together to accomplish a task, a boundary object, such as the methods of scenario planning, can emerge to allow communication and shared understandings in order to allow work to flow. Whether it be building identities, manufacturing consensus, shifting mental models, disciplining behavior, facilitating decision-making, or propagating paradigmatic thinking, the practice of scenario planning can move through different settings and accomplish work across social worlds. As a practice, scenario planning bridges social worlds, in all their diverse languages, needs, requirements for authenticity, symbolic systems and worldviews. Different views, from different social worlds are thus solicited and integrated into the scenarios via a flexible and responsive method. As explained by Suczek and Fagerhaugh, "Whenever social worlds intersect some sort of work will be needed to help bridge the social gap between them. Bridging work encompasses a multitude of facilitative tasks and work roles."[61] The methods allow such bridging work to take place.

The flexibility of the method allows the practice to be conducted in many settings and each setting can specify what kind of work is done depending on the needs of the group entertaining it. In this sense, many different social worlds can agree to the process, determine the value it affords them, and put it into practice as they see fit. However, this is not to say the flexibility begins with its ability to travel to and be employed by a variety of social worlds, but rather begins from the multiplicity of meanings that it can accommodate.

Integrity of Method

Despite the apparent ambiguities attached to such heterogeneous meaning making, there are some constraints. The method is not totally open but rather is imbued with some methodological assumptions that provide a common ground. Drawing from Star and Griesemer, the linkage here between scenarios and boundary objects is that "they have different meanings in different social worlds but their structure is common enough for more than one world to make them recognizable, a means of translation."[62] Many kinds of work can be accomplished without sacrifice of the common identity that is the thinking behind the practice. The common identity that travels with the practice is linked to *driving forces* and *mental models*.

Pierre Wack, the founding father of scenario planning, focused on perceiving *and* knowing reality, which brings to light an interesting dynamic in scenario planning and also ushers to the surface a long-standing epistemological debate. One of the goals of scenario planning, as Wack explains, is to make a "sound analysis of reality" [63] and "to see things as they really are."[64] Reality is contemplated in terms of driving forces or structural patterns *out there* for one to observe, reveal or discover. If one can only approach the world with the right state of mind and the right analytic tools, the driving forces can be accurately accounted for. In this sense, the world as an object composed of driving forces, certainties, and uncertainties, exists despite one's ability to perceive it. This view is indebted to positivism.

At the same time, scenario practitioners give primacy to mental models, or the inner landscapes that formulate perception. Here we see that knowledge is dynamic, changing and contingent upon boundaries of space, time, and perspective. There is no objective world outside of perception, or outside interpretation. Worlds are then constructed by sensing specific things about reality through a selection process that is informed by history, beliefs, specific contexts, and mental models. It is the interactions with the world that causes knowing, albeit in subjective ways. This frame is more akin to a constructivist approach as it is one that acknowledges that knowing will always be partial and thwarted by limited sight and perspective. Under

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[61] Fagerhaugh, Shizuko and Barbara Suczek. "Aids and Outreach Work." Maines, David R. (ed.). *Social Organization and Social Process: Essays in Honor of Anselm Strauss.* Aldine de Gruyter: New York,1991, 160.

[62] Star and Griesemer, 393.

[63] Wack, 1984, p. 4.

[64] Pierre Wack speaking at a "Scenario Planning Seminar" at Global Business Network, April 19, 1993.

the guidance of mental models, whether that guidance is righteous or erroneous, knowing is an *interpretation* of the world and a consequence of unique constructions, orderings, and weightings.

This is an interesting conflation of epistemologies, or in other words, a knowing that has two distinct meanings where the boundaries between the two are not clear. This practice balances ambiguously two seemingly contradicting ways of knowing. On the one hand there is a constructivist view of maps, perception, and interpretation, whereas on the other, there are forces, certainties, patterns and a reality that can be known. The world is something to be understood both subjectively vis-à-vis maps and objectively vis-à-vis forces.

The notion of boundary object usefully points to the way that shared epistemic values are embedded in the varied applications adding some semblance of coherence to the practice. Even amongst this flexibility, a common identity is maintained across sites. Boundary objects "are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites."[65] The common identity in scenario planning refers to the intellectual foundations and historical experiences that inform the methods. The understanding of an open future that is subject to external constraints in the form of driving forces and the internal constraints of limited mental models is maintained in each setting.

So while the flexibility of the method allows the solicitation of different worldviews, the practice retains some structural integrity in process and conceptions of the movement of history in terms of driving forces, or structural changes seen in the environment, independent of participants' perception of the phenomenon. While what these forces and uncertainties are specified and constructed to be remains contingent and flexible, the inclusion of the understandings and vocabularies (words such as mental models, worldviews, driving forces) maintain the common identity.

Such epistemic values provide a stable core identity to the practice. While the modes of argumentation for the use or relevance of scenario planning may change over time, the balance between surfacing a world *out there* and *in there* remains. This core feature of the methodology in turn provides some lasting stability to the practice, yet remains flexible enough to confront and adapt to changes in time.

Risks and Rewards of Flexible Methods

Flexibility is an asset in the practice. The method itself, here characterized as a boundary object, is flexible, contingent and can hold many interpretations, or "logos" of those employing it. The methods can be practiced in a variety of settings, whether public or private, for specific planning issues or concrete business decisions, in large and small groups, or between guerillas and political theorists. The methods can accommodate and enhance interactions between multiple social groups, cater to various needs and suit the whims or discretions of those involved.

Many scenario practitioners lament the lack of a firm methodology, yet simultaneously cite the interactivity and flexibility of the process an advantage that would be missed if lost. As one practitioner explains, "The practitioners have a logos of method that they apply to the situation," which follows that "one will approach one way or another depending on the situation [even if] they are using the same method." There is an appeal to a method, yet the process remains contingent upon the intuition of the practitioner and the demands of the situation.

The methods of scenario planning need to remain flexible given the primacy they afford mental models and the worldviews of the participants. The local contingency of method is so in order to elicit the interpretations

[65] Watson-Verrant and Turnbull, 128.

or perceptions of those involved in the process. It must be flexible to accommodate their different weightings, orderings, emphases, and attentions. If scenario planning is a means to make articulate participants perceptual frames, which invariably will cover a wide range of beliefs, ways of thinking, attention spans and levels of enthusiasm for different steps of the method, such flexibility can accommodate their diversity and be responsive to what comes up in the workshop. Viewing scenario planning in this light then explains the swerving from one application of the method to the other- it is a matter of tangoing with the participants and demands of each problem situation. Such a dance implicates scenario planning as an art.

However, if scenario planning is more of an art than a science, why appeal to the rigor and trappings of discipline that is bound up in the word method? Indeed, scenario planning methods are designed with specific rules and protocols and some kind of systematic ordering of how to construct the scenarios. To answer the question, two points come to focus. First, and most obviously, there is a clear advantage to associating a practice with a regimented, systematic, clear-cut way of working. It qualifies the profession and lends some credibility to the results. Indeed, the practitioners seem to exude an intellectual and business-like (and sometimes academic) manner and maintain professional attitudes. A “method” only reinforces that image. The second suggestion for the question, why bother with a method, deals with the ability to replicate. A method that can be described and canonized allows the practice to grow and spread. One can teach the method to others, create manuals, offer trainings and in the process develop experts, an organized profession and build a reputation. However, this replicability issue resurfaces its flexibility- it is replicable *because* it is flexible. It can be taught in classes and then be applied in different environments. The pupil can take the method back home and use it in their setting without necessarily bastardizing what is known as scenario planning.

Along with the benefits of flexibility, there are also risks of such methods that deal with quality control and consistency. As we began, how reliable can explorations of the future really be? A sound methodology ensures some objectivity and clarity regarding choices that becomes even more critical when dealing with essentially unknown terrain. However, if the methods are summoned selectively, such reliability is lost. This may not be a problem if the process alone yields the interesting results for the working group because the subjective weightings of the participants may be well known. The biases would be evident. Then again, scenarios ability to intersect various social worlds and represent many views in one package make them apt vehicles for circulation outside the environment from which they were created into *other* social worlds of those not involved in the creative process. What happens when scenarios move out of the generative workspace? As they become mobile, how do the ambiguities inscribed in the design and translated into the scenarios affect the interpretations by the other social worlds? How can an organization rely on scenarios without knowing the choices made in their creation? These unresolved question point to some of the difficulties with a flexible method.

Art and Science

Understanding the methods of scenario planning as a boundary object opened up for a deeper exploration of why flexibility matters and with what consequences. There is a contingency and consequential flexibility intertwined in the logos of scenario planning. As a method, scenario planning can be reproduced, taught, and transferred to new environments without loosing its identity, yet at the same time can be adopted, refined, and adapted to suit the needs of those wishing to employ it. The method is contingent, flexible, and subject to on the spot decisions. Implicating scenario methods as a boundary object demonstrated how multiple meanings could be reconciled within the practice and brought to the surface that a core identity held that practice together. This core identity is bound to two epistemological frames that unify the work practices.

Tensions between knowing and seeing, constructivism and positivism manifest in the method creating a practice where the way of knowing the world is flexible. While the methods of scenario planning have come to mean different things for different people, it is not the case that the ambiguity has left the practice meaning

nothing at all. The integrity of the method lies in its process, however loosely implemented, and in the epistemological flexibility underlying the practice. Such flexibility is critical to the success and longevity of scenario planning and routinely strengthens and fortifies the work. It is a both/and practice where flexibility leads to endurance.

Note on methods:
In addition to extensive literature review, in person interviews inform this investigation. The interviews were conducted from October 1999 to June 2000 and in the winter of 2002 in the United States, Denmark and the Netherlands. Danish (4), Dutch (4), British, French, South African, American (6), and German scenario practitioners were interviewed either formally or informally.

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4.3. Dilemmas in research evaluation - Control and/or management

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Introduction

The field of research evaluation has developed rapidly the last 10 years and can today best be described as very diversified. Methods and approaches applied to evaluate research vary extensively as well as the object for the evaluation. The object for the evaluation can be anything from the scientist to the institution to the nation state and the goals vary between organizational learning and accountability and control. The role of the evaluator too is no longer restricted to groups of scientific peers but include a growing number of professional evaluators or consultants as well as in some cases political representatives and lay persons. An idea of the complexity in research evaluation of today can be seen in Appendix A.

The recent interest in knowledge management in organizational theory has on the other hand produced a new focus on the creation and development of knowledge. The perspective is primarily on how to manage and maximize the creativity and the knowledge production in private companies in order to apply the new knowledge in commercial products. From this perspective evaluation of research relates closely to research management and the organization of knowledge production. Questions of quality can then in certain aspects be subjected to other organizational and managerial interests. The meaning and importance of the organizational context and the social relations for the development and management of knowledge in the knowledge economy has been in focus of a number of important contributions to organizational theory (Burt 1997, Brown and Duguid 2001, Nonaka 1994, Nahapiet & Ghoshal 1998, see Hansson 2002 for a review). In relation to evaluation of research and knowledge the importance of the organizational context has been formulated in recent contributions:

“The evaluation of science requires an approach in touch with knowledge of the social context of scientific work. An S&T human capital model is first a model of scientific work and its social qualities (Rogers and Bozeman, 2001); the evaluation methodology flows from this more fundamental conceptualization. Much of this capital, especially that aspect that is interpersonal and social, is embedded in social and professional networks, technological communities or knowledge or knowledge value collectives. …. none of these discounts the more traditional aspects of individual scientist’s talent, … Our concept simply recognizes that in modern science being brilliant is only necessary, not sufficient “(Bozeman, Dietz and Gaughan 2001 p. 724). Bozeman et. al. argue for an extension of the traditional approach to research evaluation with the help of concepts like social capital because it makes it possible to work with theoretical and conceptual tools combining the knowledge production and the contextual social relations. Central is the works and concepts from Pierre Bourdieu (1981, 1998), one of the first to study the scientific knowledge production as a process of work and action, combining structural, organizational processes and the cultural and personal actions and emotions. The concept of the field is central to Bourdieu: “It is the scientific field which, as the locus of a political struggle for scientific domination, assigns each researcher, as a function of his position within it, his indissociably political and scientific problems and his methods – scientific strategies which, being expressly or objectively defined by reference to the political and scientific positions constituting the scientific field, are at the same time political strategies.” (Bourdieu 1981, p. 33) ”To understand the social genesis of a field and to grasp what constitutes the specific necessity of the belief that supports it, of the language game which operates in it and of the material and symbolic stakes which are engendered in it, is to account for, to necessitate to wrest the producers’ action and the works they produce from the absurdity of arbitrariness and of motivelessness, rather than, as one ordinarily believes, to reduce or to destroy." (Bourdieu 1985, s.20). Social capital is following Bourdieu ”the aggregate of the actual or potential resources which are linked to

possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition – or in other words to membership of a group." (Bourdieu 1986)

On the background of these concepts from sociology of work and organization the paper will present evidence of the complexity of the function of research evaluation processes in the organization and the organizational influence on the 'local' understanding of quality. In the form of questions it can be formulated like:

What is the role of research evaluation in the quality control of knowledge in the modern private as well as public research organization? What constitutes quality, how is quality evaluated, and who decides? What is the role for the science community, the research organization and management and the cooperation between the researchers in the quality evaluation?

This article presents empirical evidence from a study of two public Danish research organizations[66]. The cases will describe researchers' attitudes and expectations toward evaluation and management of research with the help of two set of questions. One is about prioritizing quality dimensions in research and the possible role or influence of the research organization in the process. The other question continues the investigation of the role of the organization from the point of view of the researcher and the research cooperation by asking about a prioritizing of dimensions of competence of the researcher.

The methodology

The empirical evidence is based on case studies of four research organizations. The cases contain on 27 interviews with researchers and research managers from the research departments of two private and two government applied research organizations.

The two private research organizations have been selected with a special interest in the more established or even 'old' companies with a long tradition for investment in research and a dominant position in their respective field.

The two government research institutions for applied research were selected after the criteria of size, e.g. one large and one smaller institution.

All interviews were conducted by the author and took place inside the different organizations in the form of an open dialogue loosely following a number of prepared questions. Each interview lasted from one to one and a half hour and was recorded on tape. Supporting notes were taken during the interview.

The results presented in the following tables are parts of a larger study. Some of the results are new and unexpected. Based as they are on a rather small sample and chosen from companies willing and interested in participating in the study some warning about the validity of the results might be in place. The results alone do not constitute the outset for the creation of new theoretical explanations. On the other hand the results can be argued to present the case of 'reasonable doubt' about some of the established or traditional understandings of the foundation of the research evaluation processes in an organization.

[66] The whole study is published in Danish as part two of the authors PHD thesis, Forskningsevaluering, kvalitet og organisation, Copenhagen Business School, Copenhagen, august 2003.

Quality in research in organizations

In the classic mertonian sociology of science quality in research has been defined operationally as the outcome of the evaluation of a certain piece of knowledge (article, book, patent or product) from inside the scientific community, e.g. based on the peer review process. Recent development in science policy has focused on the relation between quality and costs, using evaluation methodology in attempts to measure quality. This has become a central question in any discussion of evaluation in science and research making it necessary to try to define operationally the hitherto vague and traditionally undefined concept of quality.

What are the quality dimensions in research and how can we measure or evaluate the quality of research? The operational definition used in this study comes from a large Norwegian study and was successfully used in an empirical study[67]. All interviewed researchers in the four case samples were asked to select and rank the two most important quality dimensions selected amongst four central quality dimensions; originality, solidity, disciplinary relevance and social relevance.

Figure 1: Dimensions of quality in private companies

	NKT Research		Haldor Topsoe	
Rank the most and second-most important dimension of research quality	most important	second most important	most important	second most important
originality	3	2	3	2
solidity	2	3	1	4
scholarly relevance			1	1
social utility - the view of the company		2		
social utility -the view of society in general		1	(6)	

The ranking of the quality dimensions by the researchers in the private research organizations show an almost equal valuing of originality and solidity – the two elements traditionally understood as the core of research quality. This is to be expected and reflects as it can bee seen in the comments to the question an awareness of originality as both the core of science and the interest in a private company in new, original knowledge to result in new products. In order to fulfil the demand the new knowledge has to be solid. “The original knowledge has to be trustworthy; it has to be solid in its foundation.”

Maybe the most unexpected result in Figure 1 is the very high priority given to the question *social utility from the view of society in general* from one company, Haldor Topsoe. Researchers as well as research managers insisted or having social utility ranked together with the more traditional dimensions and this can only be interpreted as an important indicator of the existence of a special company culture regarding research quality. This argument was very clearly supported by a number of supplement statements, for instance in the words of one young researcher: “Relevance or utility for society in general is and has always been the goal for the company in the eyes of the founder, Haldor. The chemistry we make, environmental protection, better use of resources, better food etc. is without question good for society.”

[67] The four dimensions were selected because they have been used with success in a large Norwegian survey on research quality, Gulbrandsen, & Langfeldt (1997) and by Gulbrandsen (2000).

Figure 2: Dimensions of quality in applied public research

	RISOE		By & Byg	
Rank the most and second-most important dimension of research quality	most important	second most important	most important	second most important
originality	3	6	1	
solidity	8	2	4	
scholarly relevance		8		3
social utility- the view of society in general	4	6	1	3

[68]) Note

The almost equal valuing of the originality and solidity we saw in Figure 1 has changed in Figure 2. In the public sector research organization the priority of solidity over originality is very easy to observe, even if originality is valued second by researchers from Risoe.

Figure 2 shows the high priority given to solidity and accordingly a downplaying of originality for social relevance in the public research organizations compared to their colleagues in the private research organizations.

This can of course be explained in a number of different ways but the differences in the organizational goals and policies seem very obvious to follow. Private research based companies live by continuously creating new products based on application of new knowledge. Researchers from both private companies agreed that innovation and new products have to be based on reliable, solid knowledge. But especially researchers from Haldor Topsoe underlined the relation between originality and risk-taking, stating 'that nobody has ever been fried for using millions on a non-successfully project'. The situation around risk taking and originality in knowledge creation is different for the applied public research organizations as can be seen from the following quote from a researcher in wind energy: 'one of the major success criteria in Risoe is publication in international journals, but there are problems, some results cannot be published because of cooperation with companies and our main user group, the wind mill engineers, does not read international journal – so in order to demonstrate the usefulness of our research to the sector we have to make special information presentations'. The applied research is measured against the traditional scientific standards, publication in international journals as well as by the 'social relevance', the use, distribution and application of the produced knowledge.

Quality among researchers in organizations

From the perspective of the organization and the organizational interests and policies I will shift to a perspective of the individual researcher, a kind of sociology of work perspective, where the focus is on the personal competences, e.g. what is most valuable or important in a researcher. In all four cases the normal work situation is one of team or group work, most research work is formally or informally organized in some collective way.

[68] A note on methodology: The researchers from Risoe were interviewed with a first draft of the interview scheme and were not asked to prioritize between most and second most important dimension. Based on an intensive analysis the answers have been categorized accordingly, but difference in interview questions explains the deviation in numbers.

Figure 3: The competent researcher in private and public research organizations[69]

	NKT Research		Haldor Topsoe		By og Byg	
The most important criteria when you have to evaluate the competence of a researcher	one selected	more than one	one selected	more than one	one selected	more than one
publications /patents		4		2	1	4
conferences (participation in)				1		
networks				1		
social competences	1	1		1		1
success in projects (track record)	1	1	4	1	5	1

Here we have only 3 organizations due to lack of information from one organization (Risoe). In the three research organizations the most important competence for a researcher is the ability to 'do' projects, to conduct and fulfill projects. What this means is probably a complex combination of having experience with projects and a good 'track record', e.g. having demonstrated ability to work in projects and to produce results. The second important choice is not surprisingly publications/patens, the classic scientific performance indicator. The ranking vary a bit between the three organizations but still is stands out as the second important criteria.

What should be a surprise then is the fact that the traditional indicators of quality for the individual researcher, publications/patens, does seems to be important but is clearly ranked lower and hence not as important in either organization compared to the project track record. It does not mean that this activity is unimportant in these organizations; on the contrary[70] both companies are quite productive in the more traditional scientific activities.

Conclusions about research management and questions for further research

From the interviews we have learned that differences in the overall policy and strategy of the research organization matters for the priorities of quality dimensions; researchers in private research organizations work in an organization with a long term interest or pressure - even if it never is explicit formulated – mediated through the market in the end to come up with new original knowledge to be materialized in new products. In the private research organizations originality is ranked much higher as a quality indicator among researchers than in public organizations. The public organizations rank on their side rank solidity clearly as the most important criteria. Another important result is the very clear demonstration of how important the existence of a special corporate research culture is in the case of Haldor Topsoe.

a) The private research organization

How do researchers and research managers in the private research organizations describe their own experience with this complexity? Most important is the repeated statements from researchers and research managers in both private organizations on how important it is that the research manager has a solid scientific background in the field or in related fields in order to be able to participate effectively in the person to person interaction and in the group discussions. In all case organizations I found a high level of agreement on the importance of the informal and direct personal relations, 'you have to look people in the eyes when you ask how they feel about the project to see if they mean what they say' as one research director explained and

[69] This question was not asked to the researchers from Risoe because the importance of the question became clear after the preliminary analysis of the first interviews.

[70]

continued, ‘we cannot wait and evaluate on the more formal results’. The direct interaction and personal relations based on an amount of trust is very important in these organizations, one research manager commented it this way: ‘you can never go out and say do it to a researcher’ because ‘research management is a question of making trust, you have to create a situation where people dare take risks in research knowing that management accept that it can go wrong’.

Recent studies of large research organizations, private or public has argued for the necessity of the implementation on a total scale of quality control systems (tqm, performance management systems) in research. It was a very clear message from the interviewed researchers and research managers in the two private companies that such systems had no place in these organizations. All interviewed researchers and research managers were asked about their own experience and general view on the use of quality control systems (tqm, performance management systems) in research. As a managerial tool both researchers and research managers view these systems as serious threats to the necessary risk taking consciousness[71] in research and if implemented it could result in some kind of duplication or ‘me too’ research strategy

What we found in the two private research organizations is the type of research management based on a high level of self and group organization and governance best described as third order research management (Ernø-Kjølhede et. al. 2000). To what degree is this result a product of unique or special factors operating in the two cases? The two companies have both a research director highly respected for their scientific status as well as their personal style in managing.

b) The applied public research organization

Researchers in the applied public research organizations when asked the same question on possible use of tqm systems expressed the same general attitude toward the use of quality control systems. But research managers in these organizations expressed an interest in some the quality control ideas and explained that the use of such systems has been considered in relation to applied research in order to demonstrate quality in the fierce competition with private consultancy firms. Publication and citations counts has on the other hand already been introduced as an established control system in the public research organizations in order to demonstrate public accountability for all activities in the wave of new public management. But it has in some circumstances created conflicts in the organization.

The day-to-day research work in these applied research organizations is much broader and reaches from basic research to consultancy work, technical advice and other activities in the field of application. A majority of these activities are not evaluated in the more traditional approaches to research evaluation. ‘Applied researchers do not write in international journals’ was a statement from a senior researcher at Risoe and he continued ‘even if Riso have tried to build a system to value other activities, it is international publication that counts at the bottom line’.

The general research management policy in the applied public research organizations is in many aspects not very different from the private. The work is often organized in teams or groups based on a rather informal day to day management with a high level of self management or what has been named third order management. But the management role is more formalized and the accountability and control systems are more visible in the day-to-day work. One research manager expressed his own approach to management as ‘informal management in a formal structure …informal management of the research work and formal management in the organizational work. I have people from universities who have found it a relief to have somebody who takes responsibility.’

[71] Compare the statement from several persons in Haldor Topsoe: “Nobody gets fired in this department even if they burn up several millions on a unsuccessful project”.

Questions for further research

Is the informal, direct and personal management style from the private research organizations the future? It is almost charismatic in the weberian sense based on the strong scientific authority associated with management.

Is the strong organizational research culture in a company an important or even decisive factor for an open, self-governing research organization?

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Appendix A. THE MANY DIMENSIONS OF RESEARCH EVALUATION.[72]

Evaluator ➔ / ***The evaluated unit*** ➔	*Scientific Peers*	*Professional evaluators*	*Lay persons, NGO, political groups and panel*
Individual	**Peer review of articles for publication, appointments, awards**	**Research management, researchers productivity, human resource management**	**Public debates, writing books** **Participation in media**
Institute/Department	**Modified peer review** **Rating/quality assurance** **Peer advisory board**	**Research Management:** **- marketing** **- resource managing** **- benchmarking**	**User studies (as interest groups in the field), training of young researchers, production of new knowledge (patents, products)**
Institution	**Modified peer review** **Rating/quality assurance** **Research advisory board**	**Contract steering- Negotiation of conditions (contracts)** **Resource allocation** **Benchmarking** **TQM**	**User studies (as interest groups in the field), quality, employers of candidates, users of new knowledge (business, politics)**
Cross-institutional Evaluations (institutions, disciplines, areas)	**Informed peer review, Rating/ quality assurancesite-visits, Research advisory board,Accreditation; EQUIS, ISO9000**		**Social consequences, Public hearings, consensus conferences, public or NGO advisory boards**
Territorial/-nation state National Policies	**Rating/Expert-statements, visions, scenarios, proposals.** **Evaluation and prioritation of areas,cost-benefit studies, forecasting**		**Political debates, public discussion of visions, public or NGO advisory boards**

[72] **Finn Hansson**, Department of MPP and REMAP. Workshop on Upgrading the Danish University System, CBS September 25.th 2002. also published in Fredriksen, Hansson and Wenneberg (2003).

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REMAP is a research partnership between Department of Management, Politics and Philosophy (Copenhagen Business School), Danish Institute for Studies in Research and Research Policy, RISØ National Laboratory and six research based Danish companies. REMAP is a co-operation which aims at the development of an integrated model for understanding, managing, prioritising and evaluating both public and private R&D.

In particular, REMAP deals with the identification of various complementary selection criteria and tools necessary for early assessment of knowledge creating processes. REMAP organisations co-operate and exchange knowledge and researchers.

REMAP's cross-disciplinary approach bridges the gap between theory and application, praxis and learning, knowledge accumulation and education - and between the main institutional actors in the so-called "triple helix".